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FOREST SURVEY RELEASE NO. 6

NOVEMBER 15, 1940

# FOREST RESOURCES OF THE PIEDMONT REGION OF NORTH CAROLINA

by

J. W. Cruikshank
Associate Forest Economist

A FOREST SURVEY PROGRESS REPORT

E. V. Roberts, Regional Survey Director

U. S. DEPARTMENT OF AGRICULTURE, FOREST SERVICE

Appalachian Forest Experiment Station
R. E. McArdle, Director
Asheville, N. C.

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# PREFACE

Through the McSweeny-McNary Act of 1928, Congress authorized the Secretary of Agriculture to conduct a comprehensive survey of the forest resources of the United States. The Forest Survey was organized by the Forest Service to carry out the provisions of the Act, and each of the 12 Regional Experiment Stations was made responsible for the work in its territory. In the Middle Atlantic States the Forest Survey is an activity of the Appalachian Forest Experiment Station, Asheville, North Carolina.

The work of the Survey is divided into 5 major phases:

1. Inventory. Determination of the extent, location, and condition of forest lands, and the quantity, species, and quality of the timber on these lands.

2. Growth. Determination of the current rate of timber growth.

3. Drain. Determination of the amount of industrial and domestic wood use, and the total loss resulting from fire, insects, disease, suppression, and other causes.

4. Requirements. Determination of the current and probable future requirements for forest products by all classes of consumers.

5. Policies and plans. Analysis of the relation of these findings to one another and to other economic factors as a basis for public and private policies and plans of forest land use and management.

This progress report presents preliminary information on the first three of these phases for the Piedmont Region of North Carolina, one of the four units into which the State was divided. Similar releases have been published for the two Coastal Plain Units and to complete the State a release for the Mountain Region will be published during this calendar year.

Information on the physical forest resources was obtained by a field survey made in the spring of 1937. In all, 12,737 sample plots were established at intervals of one-eighth of a mile on compass lines 10 miles apart, extending across the unit in a northeast direction. The statistical sample obtained from these plot records forms the basis for all area and volume estimates in this report, except where other sources are directly credited. Owing to the method of sampling, small tabular items have the greater probability of error and should be considered as indicating relative magnitude rather than actual values.

Data on consumption of forest products for industrial and domestic purposes were obtained by canvassing all primary manufacturing plants and a number of representative domestic consumers.

Forest Survey Staff
Assisting in the Preparation of this Report

| | |
|---|---|
| Field inventory | W. E. Houser, In charge |
| Compilation and analysis of inventory, growth and drain data | G. E. Morrill, In charge<br>T. C. Evans |

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# FOREST RESOURCES OF THE PIEDMONT REGION OF NORTH CAROLINA

## INTRODUCTION

The purpose of this report is to describe the forests and forest industries of the Piedmont Region of North Carolina. Because forests occupy nearly one-half of the land they constitute a resource that cannot be neglected in a well-planned program of land use, industrialization, and social betterment. Accurate and up-to-date data are needed to properly evaluate the relation of forests and forest utilization to the economy of the whole region.

To meet this need the report provides a brief description of the present physical, social, and industrial make up of the Piedmont. The forest resource is portrayed in considerable detail and the effect of its utilization upon industry, employment, and land use is set forth. Forest problems are presented and remedial measures suggested. Adjustments in land use, forest production, and forest products utilization are recommended to provide for more complete development of the forest resource.

## PHYSICAL CHARACTERISTICS OF THE UNIT

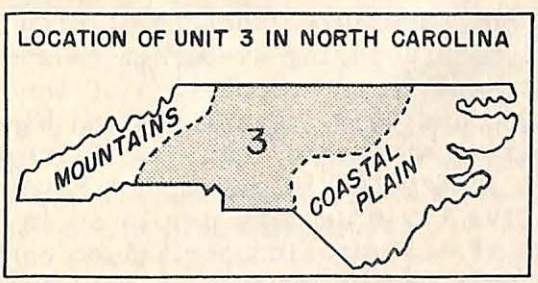


FIGURE 1

North Carolina Forest Survey Unit 3 is composed of 35 counties lying between the mountains on the west and the Coastal Plain on the east. It corresponds as closely as county lines permit with the physiographic boundaries of the Piedmont Plateau. The unit contains 10.6 million acres, approximately one-third the area of the State.

The topography is characterized by rolling hills and valleys, subdued in comparison to the rugged mountains but less monotonous than the level Coastal Plain. Elevations range from 1,000 feet in the northwestern section to about 500 feet along the "fall line" at the eastern edge of the Piedmont.

A large part of the unit contains good agricultural soils. Sandy loams, red clays, and clay loams predominate and the Cecil clay loam and the Cecil sandy loam are the two most extensive soil types. Forests grow on practically all of the soils and they occupy most of the land not used for agriculture.

The most important drainage basins of the Piedmont Region are those of the Roanoke, Tar, Neuse, Cape Fear, Yadkin, Catawba, and Broad Rivers. The Yadkin and Catawba Rivers drain more than half of the Piedmont and are especially important as a source of hydro-electric power.

## SOCIAL AND INDUSTRIAL CONDITIONS

The Piedmont supports interrelated urban, agricultural, and industrial life. Scattered throughout its entire area are large numbers of thriving villages and towns and several fast-growing cities. Compared with other southern areas this unit is highly diversified both agriculturally and industrially. Farm products include tobacco, cotton, corn, potatoes, truck crops, and dairy produce. It is the center of furniture manufacture in the South, and leads the nation in the production of cigarettes and textiles. Furthermore no other equal area in the southeast contains so many sawmills and other primary and secondary wood-products plants.

### People

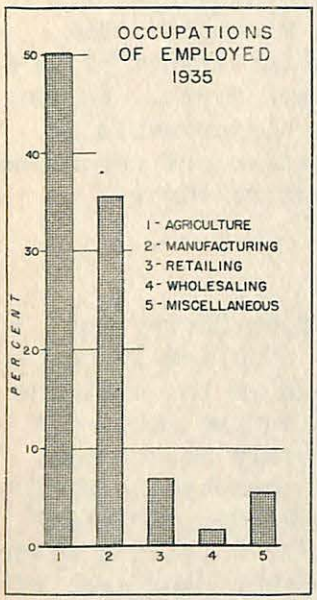

FIGURE 2

About half of the people in the State live in this unit and the proportion is increasing. The population reached 1.5 million by 1930, almost doubling in 30 years. Urban and rural population are in better balance than in most of the Southeast as 35 percent of the population is urban, 42 percent is rural, and 23 percent lives in small towns and villages. This is a result of the rapid industrialization that has taken place since 1900. The growth of several of the cities has been phenomenal. The concentration of the furniture industry at High Point and tobacco manufacturing at Durham caused an eight fold increase in the population of these cities between 1900 and 1930. Charlotte and Winston-Salem, the two cities with more than 75,000 inhabitants, have had a less meteoric growth but nevertheless contain five times as many people as in 1900. The growth of the more industrialized counties has been in part at the expense of the nearby rural counties. This drain has not been great enough to reduce the population of any county, but Alexander, Caswell, Chatham, Davie, Montgomery, and Stokes Counties remained practically constant in population between 1900 and 1930 while Guilford, Forsythe, and Gaston were increasing by 180 percent or more. Industrialization has unquestionably vitalized the Piedmont but half of the 500,000 people gainfully employed in 1935 still depended upon agriculture for their livelihood.

### Agriculture

Between 1900 and 1935 the number of farms in this unit increased by 24 percent while the land in farm ownership decreased by about 10 percent. The result has been to reduce the size of the average farm from 95 to 72 acres and to reduce the proportion of full ownership from 55 to 44 percent. According to the Bureau of the Census there were 120,000 farms in 1935, containing 8.5 million acres. The average farm consisted of 35 acres of woodland, 27 of cropland, 5 of pasture, and 5 devoted to miscellaneous uses. The practice of subdividing the farm acreage into more and smaller farms is causing a gradual reduction in the size of the average farm woodland, a trend that may eventually limit farm forest products to little more than fuelwood for home consumption.

The value of crops and livestock produced in 1935 was approximately 85 million dollars, according to data published by the North Carolina Crop Reporting Service. The tobacco crop was valued at 37 million dollars, cotton at 14 million, corn at 13 million, livestock at about 7 million, and miscellaneous crops the remainder. The Census of Agriculture also reported one million dollars worth of forest products sold from farms in 1934. The per-farm value of cash crops harvested was about 450 dollars. By comparison, forest products from farms returned about 90 dollars in cash per farm to the 10 percent of farms reporting sales of forest products.

## Manufacturing

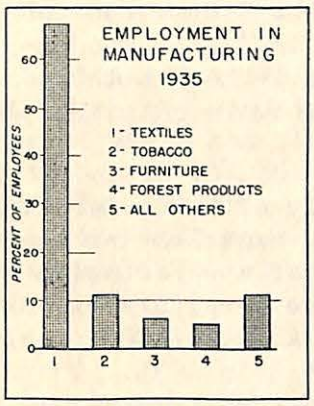

FIGURE 3

The Piedmont of North Carolina has experienced a tremendous industrial expansion since 1900. In the whole State at the beginning of the century there were only 70,000 employees in all manufacturing industries, receiving only 14 million dollars in wages and producing goods valued at 95 million. By contrast, in 1935 the industries of the Piedmont alone gave employment to about 220,000 employees, earning about 100 million dollars, and producing goods valued at close to a billion dollars. The major factor responsible for this industrial growth has been cheap and abundant hydro-electric power, of which large-scale commercial development began about 1900. Ample supplies of raw material such as cotton, tobacco, and forest resources, as well as an adequate supply of labor and nearness to markets were important contributing factors. Within a radius of 500 miles of the center of the Piedmont is half the population of the United States and a majority of the more concentrated urban markets.

Textiles: North Carolina leads the nation in textile production. The Census of Manufactures reported about 640 textile mills in the State in 1935, of which nearly 600 were located in the Piedmont. Gaston, Mecklenburg, and Guilford Counties are important textile producers, and the towel mills at Kannapolis, the hosiery mills at Durham, and the denim mills at Greensboro, rank among the world's largest. Approximately 150,000 people were employed in 1935 in the textile mills of the Piedmont, where they earned about 100 million dollars in wages, and produced goods valued at close to 400 million dollars.

Small quantities of wood products are required by the textile industry. Wooden shuttles, picker sticks, spools, bobbins, cones, cobs, and quill boards are used in the spinning and weaving processes. Part of the wood for the shuttles and picker sticks is cut in this unit. Dogwood is favored for shuttles because it is heavy, hard, and strong and wears smooth with continued use while hickory has been found best for picker sticks. The essential high-quality trees of these species are scattered through the Piedmont and less than 500 cords of dogwood and 100,000 board feet of hickory were cut for these products in 1937.

Tobacco: North Carolina is the leading state in the manufacture of tobacco, specializing in the production of cigarettes and smoking tobacco. Factories at Durham, Winston-Salem, and Reidsville, all in the Piedmont, account for practically all of the State's output. According to the Census of Manufactures the tobacco manufacturing industry furnished employment to about 17,000 people in 1935, who earned 13.5 million dollars and made products valued at 463 million dollars.

The forests of the Piedmont contribute materially to the conduct of the tobacco industry. Forty percent of the United States tobacco crop is grown in North Carolina and about one-third of the State's production is grown in the Piedmont, in 1937 about 180 million pounds. Curing and storing this immense quantity of tobacco requires a large amount of wood, which is cut locally. Firewood is used for curing most of the flue-cured tobacco, the curing leaves are hung upon wooden tobacco sticks in log or wooden-frame curing barns, the tobacco is sold at the markets in wooden tobacco baskets, and is stored in wooden hogsheads. The firewood requirement alone exceeded one-third of a million cords in 1937.

Furniture: The furniture manufacturing industry of North Carolina started at High Point in 1888. It has grown steadily, experiencing especially rapid development between 1914 and 1919. Most of the factories are located in the Piedmont, and High Point, with its large furniture exposition building, is the furniture center of the South. About 14,000 people were employed in the 150 furniture factories of the unit in 1935. They received about 9 million dollars in wages and produced furniture valued at nearly 35 million dollars.

The original establishment of the furniture industry in the Piedmont of North Carolina was due largely to the abundant supply of good-quality oak timber. The hardwood timber supply has not kept pace with the rapidly growing industry, however, and today much of the hardwood must be shipped several hundred miles to the factories. Nevertheless, the local forests provide raw material for about 40 plants making furniture veneers and dimension stock, for the sawmills cutting the estimated 20 million board feet of pine crating material required each year, and for the limited number of sawmills cutting hardwood lumber for furniture use.

Forest products. In addition to furniture factories the Piedmont of North Carolina contains an abundance of wood-using plants. Those using wood direct from the forest are most numerous, numbering about 1,660 in 1937. Small portable sawmills comprise the majority of these establishments but there are more than 50 plants making either veneer, furniture dimension, handle or shuttle blocks, cooperage, or tobacco baskets. These primary forest industries will be discussed in more detail later in the report. Secondary plants that buy semi-finished material for further manufacture, include those making finished lumber, millwork, wooden containers, plywood, and miscellaneous wood products such as coat hangers, wash boards, and toys. Altogether there were nearly 1,750 wood-products plants in 1937. They employed about 10,000 people, exclusive of woods labor, and manufactured products valued at about 10 million dollars.

## Power

A description of the Piedmont would be incomplete without brief mention of its power resources. Beginning in 1898 with a small plant in the Yadkin River at Idols, hydro-electric development has proceeded rapidly until today there are 21 plants with a capacity of nearly 500,000 horsepower. Four steam generating plants provide an additional 330,000 horsepower and a fifth one of large capacity is under construction in Rutherford County. Abundant cheap power has been a major factor in the development of the tobacco, textile, and furniture industries. Forest-products industries have made infrequent use of electric power in the past but present-day veneer plants, planing mills, and dimension stock mills are using electricity for power and its use by other wood-products plants will increase as local distribution lines tap more rural communities.

Steam-electric plants are generating an increasing amount of the electric energy used in the Piedmont. They have become remarkably efficient in recent years and it is probable that they will be utilized for new installations in all but the most favorable hydro-electric locations. Water control is a major problem of the existing hydro-electric plants. The forests of the unit have a strong beneficial influence upon stream flow because they reduce flood crests, retard erosion, and check silting of rivers and reservoirs.

## Taxation

The assessed value of all real and personal property in the Piedmont amounting to 1.4 billion dollars was 60 percent of the State total in 1937. It was taxed at county-wide rates varying from 48 cents to $2.00 per $100 of assessed valuation and yielded about 11.7 million dollars in taxes. Assuming an average tax of 15 cents per acre on forest land and timber the forests of the unit were the base for about 6 percent of the county taxes.

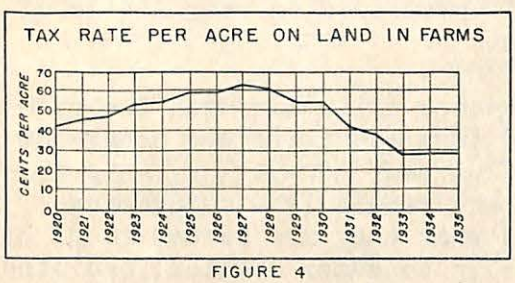

FIGURE 4

Because 85 percent of the forest land is on farms the trend of farm tax rates has a direct bearing upon forest land tax costs. Figure 4 is based upon only 10 counties of the Piedmont but it shows how the tax rates rose steadily during the years of increasing income, and how they fell during the depression years.1/ While the tax rate tends to follow farm income changes there is usually a lag in adjusting it to a declining farm income. Occasionally this causes premature cutting of farm forests in order to obtain money for taxes.

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1/Forster, G. W. Recent changes in tax rates on farm real estate in North Carolina, N. C. Agr. Exp. Sta., Information Series No. 3, Nov. 1937.

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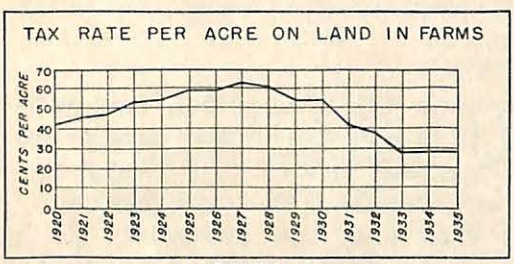

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For taxation purposes forest land is generally classified by tax assessors as wasteland, cutover land, woodland, or timber land. Allocation of forest land into these four classes is not uniform among counties. Data obtained in 1937 in four counties of the Piedmont indicates the range in assessments and taxes per acre.2/ Woodland was assessed at $10.83 in Rutherford County and $20.88 in Durham County, while timber land varied from $7.73 in Rutherford County to $26.54 in Iredell County. The average tax per acre ranged from 4.7 cents on wasteland to 35.6 cents on timber land. The Exemption Law passed in 1939 is of particular importance to farmers who wish to plant trees on abandoned farm land. It instructs tax assessors to make no increase in the tax valuation of reforested land until 10 years after such planting.

## Land Ownership and Use

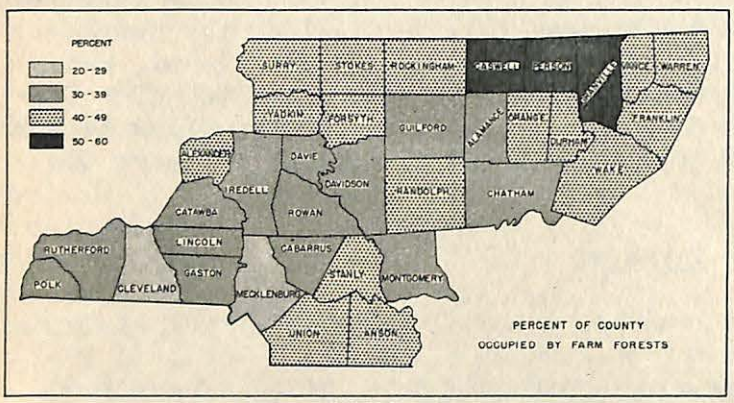


FIGURE 5

Eighty-five percent of the forest land in the unit is in farm ownership. Industrial ownership by forest-products industries is very limited, probably totaling less than 50,000 acres in tracts generally smaller than 1,000 acres. Federal ownership is limited to 23,000 acres in Davidson, Montgomery, and Randolph Counties that make up part of the Uharie Forest Purchase Unit. The State owns 7,300 acres in the Hanging Rock and Morrow Mountain State Parks, located in Stokes and Stanley Counties, respectively. The remaining forest area, about 700,000 acres, belongs to power companies, local townspeople, and other private owners. Planned sustained yield management is practiced on very little of the forest land, probably less than 10 percent.

The use of land in the Piedmont now depends primarily upon the customs, attitudes, and practices of the 120,000 farm operators who manage 80 percent of the land. These operators are influenced, however, by many factors over which they have no control and the end result is a compromise between what the farmers would like to do and what they are forced to do by governmental action, loss of markets, changes in consumer demands, and other economic conditions. Such far-off developments as England's recent trade agreement with Turkey will probably cause a reduction in the tobacco acreage in this unit and may cause some land abandonment.

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2/Nelson, R. W. Taxation of forest property in North Carolina, Forest Taxation Inquiry, U. S. Forest Service.

According to the Survey, approximately the same amount of land was used for agriculture as for forest in 1937 (table 1). This proportion may change in the future in favor of forests because the constant increase in yields of agricultural crops per acre reduces acreage requirements. On the other hand urban population growth is extremely rapid in this unit and greater emphasis upon agricultural production for local consumption may cause an increase in agricultural land use. At the same time a growing population creates an increased demand for fuelwood, building material, containers, furniture and other wood products which the present forest cannot satisfy. Gradual adjustments in land use will undoubtedly occur, but at best they will be haphazard until a coordinated long-time land-use plan is prepared for each county of the unit.

Table 1. - Total land area classified according to major use, 1937

| Land use* | Area | Proportion of total area |
|---|---|---|
| | Acres | Percent |
| Forest: | | |
| Productive** | 4,968,100 | 47.0 |
| Nonproductive | 4,100 | Negl. |
| Total forest | 4,972,200 | 47.0 |
| Nonforest: | | |
| Agriculture: | | |
| Old cropland | 4,563,500 | 43.1 |
| New cropland | 127,900 | 1.2 |
| Pasture | 289,900 | 2.8 |
| Total agriculture | 4,981,300 | 47.1 |
| Abandoned cropland | 121,300 | 1.1 |
| Other nonforest | 505,000 | 4.8 |
| Total nonforest | 5,607,600 | 53.0 |
| Total area | 10,579,800 | 100.0 |

*Refer to glossary for description of terms.
**Productive forest area used throughout the report.

## DESCRIPTION OF THE FOREST RESOURCE

Historical records and studies by ecologists indicate that the original forest of the Piedmont was a mixture of hardwoods, chiefly oak and hickory, with a small amount of pine. Ashe[3/] believed the best-quality and purest stands of hardwood were between the mountains and a line drawn through the present cities of Charlotte, Salisbury, and Greensboro. It seems probable that shortleaf pine was developed best in the northeastern portion of the Piedmont and loblolly pine on the level lands along the southeastern border.

A rather rapid cycle of land clearing and land abandonment continued until the latter part of the past century, since then it has proceeded at a slower pace. The abandoned fields, with their exposed mineral soil, have provided an excellent seedbed for the light, wind-borne seeds of the occasional pine trees in adjacent timber stands. A high proportion of the total area of the Piedmont has been subjected to this seeding process and the result was to change the characteristic type from mixed hardwoods to old-field pine. How long the pine types will continue to be dominant under the more stable land-use practices of today is problematical, but at the time of the Survey in 1937 they occupied three-fourths of the 5 million acres of forest land.

### Species

Shortleaf pine is the most abundant tree in respect to both number of stems and board-foot volume. It is distributed throughout the Piedmont on the better-drained soils but is most prevalent southeast of Statesville, Winston-Salem, and Greensboro (fig. 7). Loblolly pine ranks next in abundance and occurs chiefly in Warren, Franklin, Wake, Chatham, and Anson Counties. Virginia pine, often called scrub pine because of its brushy appearance, occupies a broad belt along the northern boundary from Caswell County west to the mountains and southwest along the mountains to South Carolina.

Yellowpoplar is found throughout the unit although it is rather infrequent in Stanley, Union, and Anson Counties. Sweetgum is most prevalent east of Caswell, Alamance, and Chatham Counties in conjunction with the loblolly pine-hardwoods type (fig. 7) but it is common everywhere. Merchantable trees of the red and white oaks, hickories, and eastern redcedar are widely scattered and only in rare instances do any of these species form extensive merchantable stands. The larger trees of the several species are most frequent in the areas outlined in figure 6, but even in these localities they are of scattered occurrence.

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3/Pinchot, G. and W. W. Ashe. Timber trees and forests of North Carolina. Bul. 6., North Carolina Geological Survey, 1897.

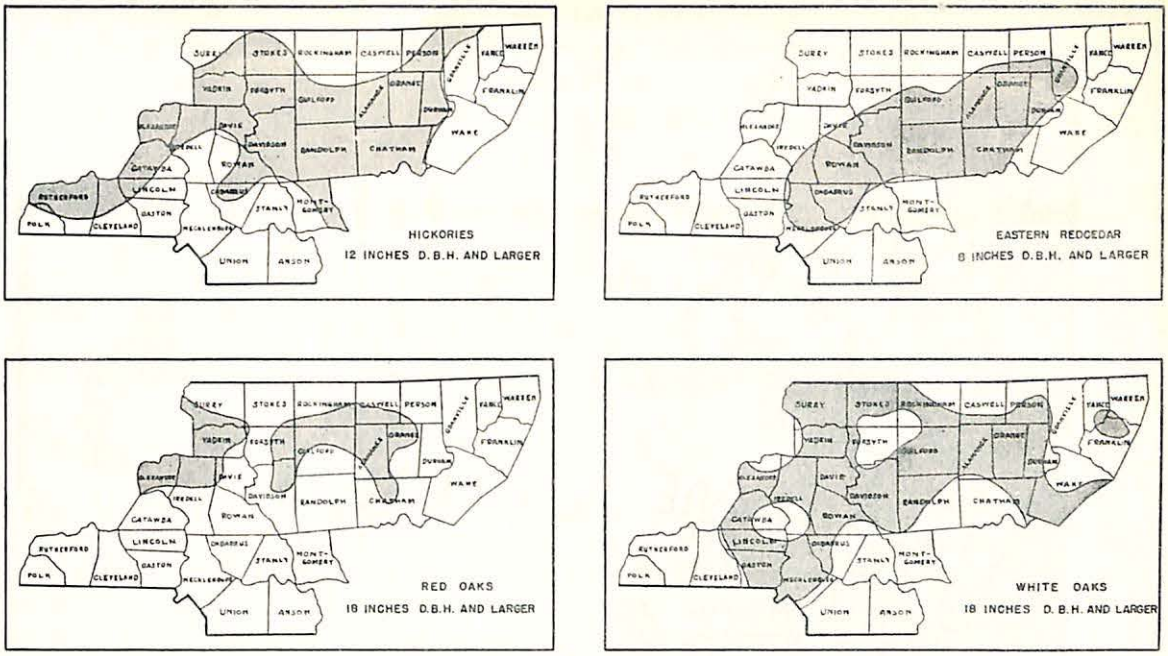
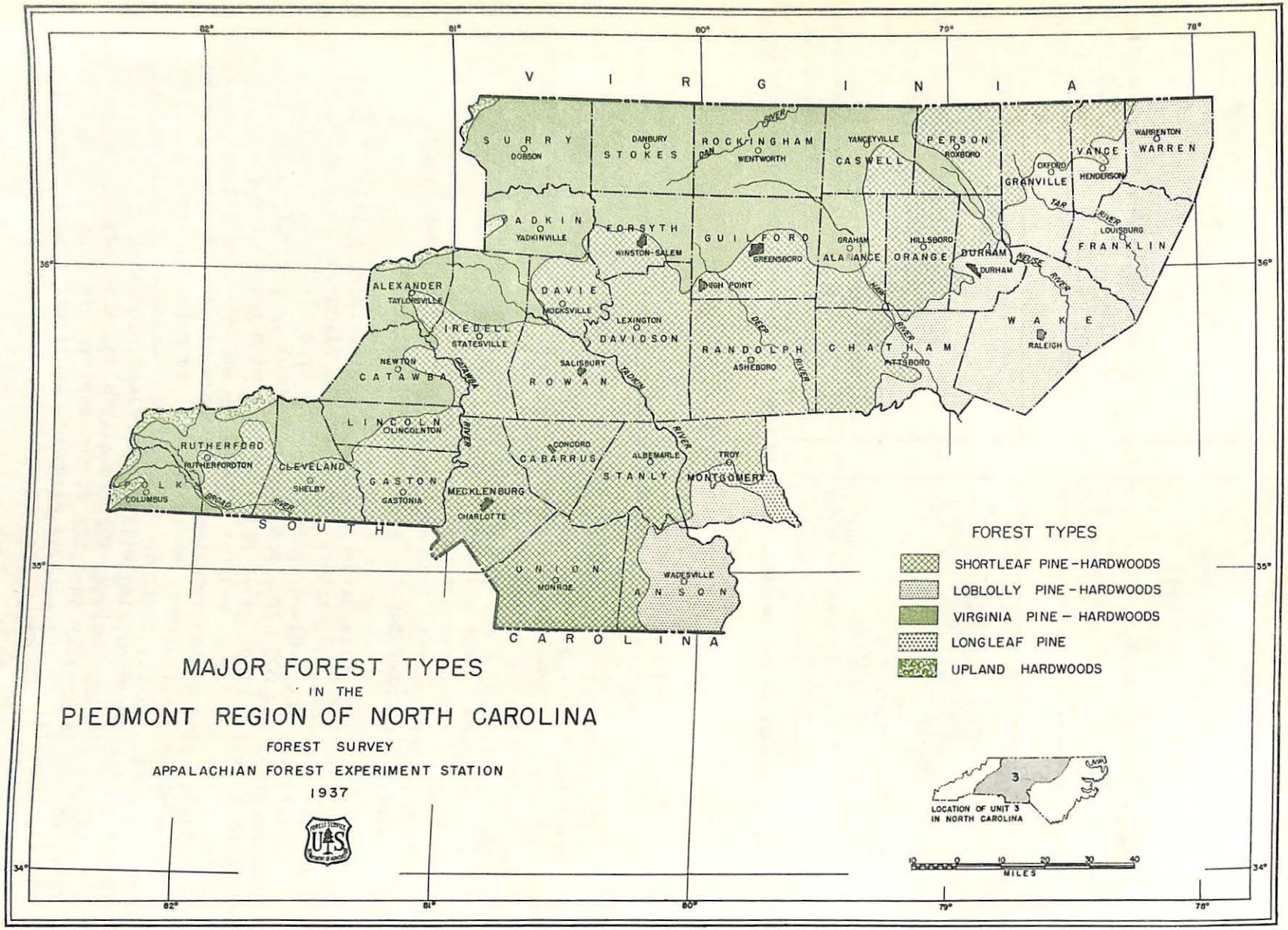



FIGURE 6.– LOCATION OF THE PRINCIPAL SUPPLY OF LARGE OAKS, HICKORIES, AND EASTERN REDCEDAR

## Forest Types

The forests of the Piedmont were classified by the Survey into forest cover types on the basis of stand composition and the proportion of commercially important dominant trees. The type areas given in the forthcoming tables are based upon the number of plots that were recorded in the various forest types and are a reasonably accurate measure of the extent of the various types in the unit. The forest type map, however, is merely a delineation of the broad areas in which given forest types predominate and it does not show accurate type areas, included agricultural land, or local variations in the predominant forest cover (fig. 7).

The loblolly pine-hardwood type, which occupies a belt of land about 30 miles wide along the eastern border of the Piedmont, is contiguous with, and similar to, the loblolly pine-hardwoods type of the Coastal Plain. It contains about 639,000 acres and makes up about 13 percent of the total Piedmont forest. Practically pure loblolly pine stands occur on three-fifths of the type area, while a variety of hardwood species are mixed with the loblolly pine on the remainder. Sweetgum and yellowpoplar grow with the pine along small streams where the soil is more fertile and moisture more abundant. Black, southern red, and post oaks are more often associated with it on the drier rolling hills. Shortleaf pine also forms an appreciable part of the type volume, particularly along the western limit of the type. As the sandy-clay subsoils of the eastern Piedmont give way to the red clay subsoils of the central Piedmont, shortleaf pine becomes the dominant species.




MAJOR FOREST TYPES
IN THE
PIEDMONT REGION OF NORTH CAROLINA

FOREST SURVEY
APPALACHIAN FOREST EXPERIMENT STATION
1937

Figure 7

The extent of the shortleaf pine-hardwoods type is shown in figure 7. It is the major type of the unit, occupying 2.3 million acres, 47 percent of the forest land. Stands of shortleaf pine, generally of old-field origin, occupy about half of the type area, while on the other half the stands are composed of shortleaf pine, white, black, southern red, and scarlet oaks, yellowpoplar, hickories, and a variety of other hardwood species. Eastern redcedar often occurs as a thin understory in these pine-mixed hardwood stands, but its total volume is relatively insignificant. Loblolly pine merges with shortleaf along the border of the two type areas and is sometimes found in the stream valleys that cross the shortleaf pine belt. Virginia pine also intrudes into the shortleaf pine-hardwoods type along its western border and as the compact red clay loams of the central Piedmont change to sandy loams in the northern Piedmont and foothills region it largely replaces shortleaf pine in the forest stand.

The forests classified as Virginia pine-hardwoods occupy about 600,000 acres, 12 percent of the wooded land in the Piedmont. They extend from the typical rolling country of the central Piedmont northward and westward to the base of the Blue Ridge. Virginia pine, with only a small admixture of other species, occupies three-fifths of the forested land. Most of this pure pine is of old-field origin. Forest-grown stands typically include a mixture of hardwoods, such as white, post, black, scarlet and chestnut oaks, yellowpoplar, hickories, sweetgum, sourwood, and dogwood. Shortleaf pine occurs with Virginia pine both in old-field and forest grown stands.

The upland hardwoods type includes local bodies of hardwood intermingled with the pine types. Often of small size, these tracts of hardwood are distributed throughout the unit and in the aggregate occupy 24 percent of the forest land. Although predominantly an oak-hickory type the species composition varies widely in different localities, being influenced by soil, slope, elevation, and moisture conditions. White oak (Quercus alba) is most abundant, but post, southern red, northern red, scarlet, black, and chestnut oaks, hickories, yellowpoplar, sweetgum, dogwood, maple, ash and many other species occur on the sites favorable to their development.

The strips of lowlands along most of the rivers are not wide although a few broad flats occur near some of the larger streams in the eastern Piedmont. The bottom-land hardwoods type is, therefore, restricted to narrow valleys along the larger rivers, to the occasional broad flats, and to the margins of the smaller streams. In all, this type occupies only 4 percent of the forest area. The soils along the larger rivers are generally a silty alluvium conducive to the growth of sweetgum, yellowpoplar, swamp chestnut oak, water and willow oaks, hickories, sycamore, elm, and blackgum. On the flats, willow and water oaks predominate. The sandy loams bordering the small streams support beech, river birch, red maple, yellowpoplar, sweetgum, willow, and a scattering of red and white oaks. Loblolly pine is frequently seen along both large and small streams in the eastern part of the Piedmont and shortleaf pine occasionally extends into the smaller bottoms of the upper Piedmont.

The species composition of the five forest types is expressed by means of percentages in table 2. The cubic-foot volumes upon which the proportions are based contain both wood and bark of all sound trees 5.0 inches d.b.h. and larger. The full stems to a minimum 4-inch top of all pines and under-sawlog-size hardwoods are included as well as the sawlog portion of merchantable hardwoods. Measured in this way, the leading species in the unit are shortleaf pine, loblolly pine, white oaks, Virginia pine, and the red oaks.

Table 2. - Species composition of the forest types

| Species | Shortleaf pine-hardwoods | Loblolly pine-hardwoods | Virginia pine-hardwoods | Upland hardwoods | Bottom-land hardwoods | All types |
|---|---|---|---|---|---|---|
| | Percent of cubic volume (o.b.) | | | | | |
| Shortleaf pine | 70.2 | 10.2 | 15.8 | 6.6 | 2.0 | 40.8 |
| Loblolly pine | 3.3 | 70.3 | 0.3 | 0.8 | 3.4 | 12.5 |
| Virginia pine | 3.3 | 0.2 | 61.5 | 0.9 | 0.1 | 7.7 |
| Eastern white pine | 0.1 | -- | 0.4 | 0.2 | -- | 0.1 |
| Eastern redcedar | 0.7 | 0.2 | 0.4 | 0.4 | 0.1 | 0.5 |
| Sweetgum | 2.4 | 5.6 | 1.3 | 4.1 | 21.7 | 4.0 |
| Yellowpoplar | 3.7 | 3.3 | 5.5 | 8.6 | 14.0 | 5.3 |
| Red oaks | 4.5 | 2.0 | 3.9 | 20.3 | 5.0 | 7.1 |
| White oaks | 6.0 | 3.0 | 5.2 | 31.2 | 5.9 | 10.2 |
| Hickories | 2.4 | 1.0 | 2.1 | 14.0 | 3.0 | 4.4 |
| Dogwood* | 0.5 | 0.3 | 0.5 | 1.1 | 1.1 | 0.6 |
| Scrub hardwoods** | 0.7 | 0.4 | 0.5 | 2.0 | 0.8 | 0.9 |
| Other hardwoods | 2.2 | 3.5 | 2.6 | 9.8 | 42.9 | 5.9 |
| Total | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |

*Includes persimmon, black locust, holly, and mulberry.
**Includes scrub oaks, sassafras, and sourwood.

## Forest Conditions

The forest stands were also grouped into forest condition classes on the basis of tree-diameter, age, volume-per-acre, and cutting history. Old-growth stands occupied 9 percent of the forest land, second-growth sawlog-size stands 43 percent, and under-sawlog-size stands 48 percent.

It would be erroneous to assume that the 464,000 acres of old-growth timber are all original virgin forest (table 3). The forest stands classified as old growth may, in the case of pine, contain trees only 70 years old, but equal in quality to virgin growth. In the upland hardwoods, where half of the old growth occurs, the trees are frequently only the low-quality species left from the original stand, for in both the hardwoods and pine three-fourths of the old growth has been culled for selected species or sizes. Most of the pine old growth is in the shortleaf pine hardwood type, where it typically occurs as small scattered patches of a few acres each. These small areas are nowhere abundant but are most frequent in the western

part of the Piedmont along the base of the Blue Ridge. The old-growth hardwoods are equally irregular in local occurrence, but are most common east of Caswell, Alamance, and Randolph Counties.

Table 3. - Forest area classified according to forest condition and forest type, 1937

| Forest condition | Shortleaf pine-hardwoods | Loblolly pine-hardwoods | Virginia pine-hardwoods | Upland hardwoods | Bottomland hardwoods | Total all types | Proportion of total |
|---|---|---|---|---|---|---|---|
| | Acres | | | | | | Percent |
| Sawlog size: | | | | | | | |
| Old growth: | | | | | | | |
| Uncut | 42,300 | 3,300 | 2,500 | 44,000 | 15,000 | 107,100 | 2.1 |
| Partly cut | 107,200 | 30,700 | 7,500 | 181,100 | 30,700 | 357,200 | 7.2 |
| Total | 149,500 | 34,000 | 10,000 | 225,100 | 45,700 | 464,300 | 9.3 |
| Second growth: | | | | | | | |
| Uncut | 662,900 | 149,500 | 181,900 | 189,400 | 59,000 | 1,242,700 | 25.0 |
| Partly cut | 450,200 | 171,100 | 70,600 | 167,800 | 27,400 | 887,100 | 17.9 |
| Total | 1,113,100 | 320,600 | 252,500 | 357,200 | 86,400 | 2,129,800 | 42.9 |
| Total sawlog size | 1,262,600 | 354,600 | 262,500 | 582,300 | 132,100 | 2,594,100 | 52.2 |
| Under sawlog size: | | | | | | | |
| Second growth | 966,900 | 248,400 | 291,500 | 597,200 | 76,400 | 2,180,400 | 43.9 |
| Reproduction* | 84,700 | 35,700 | 51,500 | 17,500 | 4,200 | 193,600 | 3.9 |
| Total | 1,051,600 | 284,100 | 343,000 | 614,700 | 80,600 | 2,374,000 | 47.8 |
| Total all conditions | 2,314,200 | 638,700 | 605,500 | 1,197,000 | 212,700 | 4,968,100 | 100.0 |
| Percent of total | 46.6 | 12.8 | 12.2 | 24.1 | 4.3 | 100.0 | |

*Includes 4,200 acres of clear-cut condition.

Second growth saw-timber stands occupy 43 percent of the forest land, or 2.1 million acres. About half of this merchantable second growth is in the shortleaf pine-hardwoods type, 17 percent is in upland hardwoods, 15 percent is in loblolly pine-hardwoods, 12 percent is in Virginia pine-hardwoods, and only 4 percent is in bottomland hardwoods. Light cutting has removed part of the saw-timber volume on 42 percent of the total area in this condition and in the loblolly pine-hardwoods type, where the best saw timber occurs, 53 percent of the area has been partly cut. Sawlog-size stands prevail throughout the Piedmont, but most abundantly east of the Yadkin River.

The forest area stocked with under-sawlog-size trees over one inch in diameter is equal to the area of sawlog-size second growth. Even in these young stands partial cutting, caused undoubtedly by the intense demand for fuelwood, has occurred on 15 percent of the area. Pine types

occupy 70 percent of the area as compared to 80 percent in second-growth sawlog-size stands. Blocks of young timber are inter-mixed with saw-timber stands throughout the Piedmont and do not appear concentrated in any one locality.

Scarcely any of the forest land is in the clear-cut condition and less than 4 percent is classified as reproduction. These reproduction areas have sufficient seedlings and sprouts of commercial species to develop into commercial stands, indicating that natural reforestation is taking place on most cut-over land. In many cases, however, this natural replacement is extremely slow, the trees are often poorly spaced, and desirable species do not always occupy the land.

## Site Quality

Site quality is a measure of the productivity of forest land. It is influenced by many factors, but chiefly by soil and climate. Although expressed in several ways, an index commonly used is that based upon the height of average dominant trees at 50 years of age. This method of estimating site quality was used in the Piedmont where the land in each pine type was classified by index determination of the pine species controlling the type classification.

Apparently the abandoned fields of the central Piedmont are rather poor sites for pine, as well as for cotton, because 84 percent of the shortleaf pine-hardwoods type area has a site index of not more than 60 feet (table 4). On good shortleaf sites, such as those of southeast Alabama, only 50 percent of the type area has such a poor site index. The Virginia pine-hardwoods type area in the western Piedmont is also poor in site quality although the inferior showing may be partly due to the growth characteristics of Virginia pine. The rolling hills bordering the Coastal Plain are excellent sites for loblolly pine, as 90 percent of the loblolly pine-hardwoods type has a site index of 70 feet or more. By comparison, equally good sites occur on only 80 percent of the loblolly pine area in the Coastal Plain.

Table 4. - Pine-hardwoods area classified according to site

| Index species for corresponding pine type areas | Site index in feet | | |
|---|---|---|---|
| | 90 or more | 70 and 80 | 60 or less |
| | - - - - - - - - - - Percent - - - - - - - - - - | | |
| Shortleaf pine | Negl. | 16 | 84 |
| Loblolly pine | 5 | 85 | 10 |
| Virginia pine | -- | 8 | 92 |

The importance of site quality should not be minimized for it is the basic factor controlling yields of wood. Usually it can be improved by intensive fire control and silvicultural practices but it is a long, slow process. Profitable forestry requires a thorough knowledge of the yield potential of the forest land under management, because it is frequently possible to produce more wood at less cost on a small area with a good site index, than on a much larger area with a poor site index. For instance, about three-fourths as much timber can be produced on the good sites occupying 30 percent of the Piedmont pine area as on all the rest of the pine land.

## Age

Young, even-aged stands of old-field origin are characteristic of the pine types in the Piedmont. Stands in the various condition classes do not vary greatly in age by forest type, most of the under-sawlog-size pine timber is below 30 years of age and most of the sawlog-size second-growth pine is 30 to 60 years old. The minimum age of pine timber of old-growth quality is 70 years.

The hardwood stands are older and less even-aged than the pine stands. Many of the older stands have an understory of younger age-classes present but where cattle grazing is intensive younger trees are scarce or absent. Most of the hardwoods are sawlog size when 50 to 60 years of age. They require longer to reach merchantable size because they grow slower than pine and the minimum diameter limit for hardwood saw timber is higher. Practically all of the old-growth hardwoods are more than 100 years old.

A proper area distribution of age-classes is essential for continuous forest production. Well-managed forests have at all times the proportion of young, middle-aged, and old stands that will insure a steady supply of harvestable timber. The proportionate area in each age-class will vary with the length of rotation and method of management. Rotations are influenced by species, site, product, and financial considerations and management methods may vary from selection cutting to clear-cutting and planting.

The Piedmont forest is a composite of many thousand small forest areas, each managed or abused in a slightly different way. A correct area distribution for the forest as a whole can only be accidental under such circumstances, but reference to figure 8 shows the present proportions are not altogether unfavorable for continuous production of saw timber. A rather large proportionate area is stocked with trees below 40 years of age in the Virginia pine-hardwoods and loblolly pine-hardwoods types but the shortleaf pine-hardwoods type, which occupies nearly half the forest area, is reasonably satisfactory in age-class distribution. There is a noticeable lack of pine-hardwood stands more than 80 years old but this is not serious because excellent pine saw timber can be grown on an 80-year rotation. The upland hardwoods have a large area in the oldest age-class but most of these stands have been severely culled.

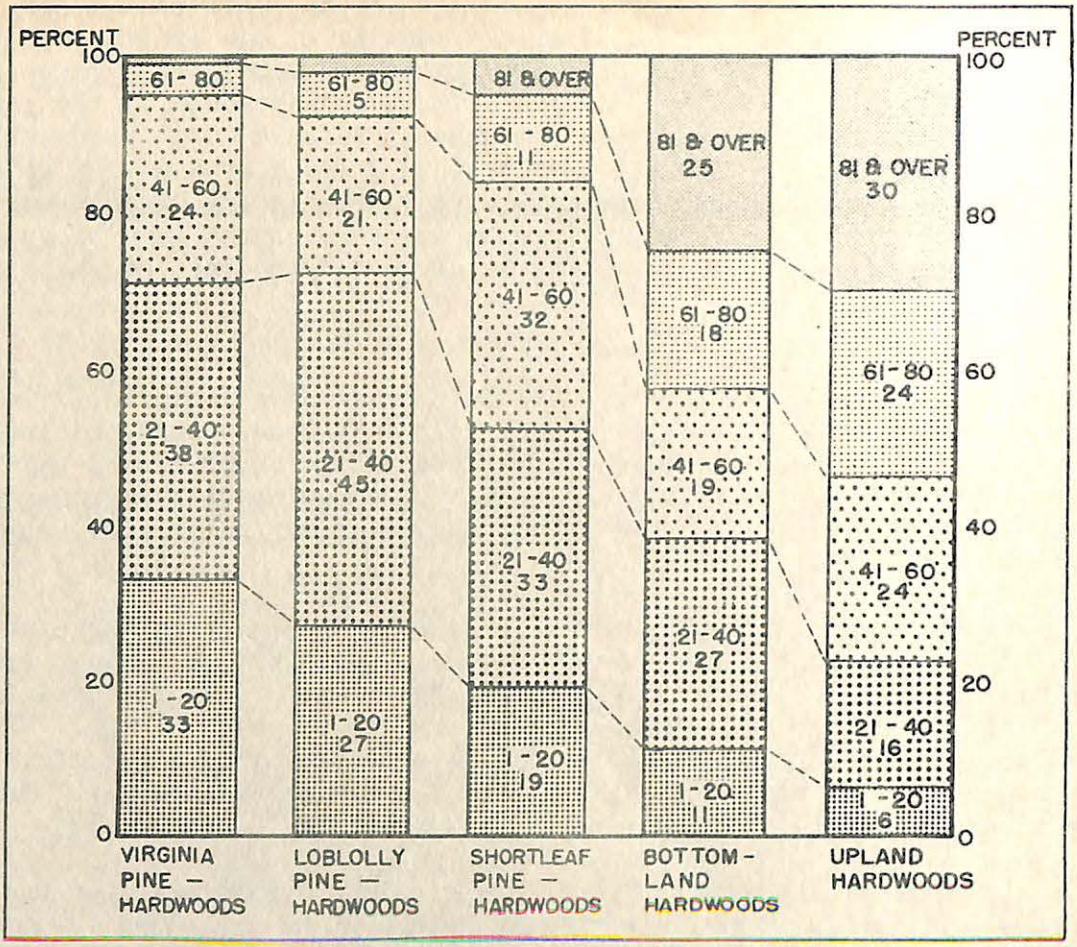



FIGURE 8.- PERCENT OF FOREST TYPE AREAS IN 20-YEAR AGE-CLASSES, 1937

## Stocking

In general, the forests of the Piedmont are understocked. This means a large proportion of the forest land can support more trees per acre and by so doing can produce greater annual yields of better-quality wood. How much greater these yields can be depends upon the degree of present understocking and the application of correct methods of forest management. At the outset it should be realized that some stands are too heavily stocked and can be improved by thinning, while the vast majority are too thinly stocked and should be built up for greater productivity of wood in both quantity and quality.

The stocking of the shortleaf pine type serves to illustrate the general situation throughout the unit. This type occupies almost one-fourth of the forest land, is dominantly pure shortleaf pine, and commonly occurs in even-aged stands. It should not be confused with the combined shortleaf pine and shortleaf pine-hardwoods type which occupies 47 percent of the forest area.

To arrive at an estimate of stocking in the shortleaf pine type the average cordwood volume per acre of uncut stands in each age-class is compared with the average volumes, weighted by site, of the best-stocked 10 percent of these same stands (table 5). The volumes-per-acre occurring in the best 10 percent of the stands closely approximate full stocking. By comparison, the average stand in the 11 to 20-year age-class is only 24 percent stocked while the oldest average stands are 69 percent stocked. The average stands obviously approach full stocking as they grow older. The rate of approach is rapid in the younger stands, gradually tapering off as they reach maturity.

Table 5. - Average volumes per acre, by age-classes, in the uncut conditions of the shortleaf pine type

| Age-class | Based on all stands | Based on best 10 percent of stands | Relation of all stands to best 10 percent |
|---|---|---|---|
| Years | Cords | Cords | Percent |
| 11 - 20 | 2.0 | 8.5 | 24 |
| 21 - 30 | 9.0 | 21.0 | 43 |
| 31 - 40 | 20.0 | 35.5 | 56 |
| 41 - 50 | 25.5 | 42.5 | 60 |
| 51 - 60 | 28.5 | 46.5 | 61 |
| 61 - 70 | 31.0 | 48.5 | 64 |
| 71 - 80 | 33.0 | 49.0 | 67 |
| 80 and over | 34.0 | 49.0 | 69 |
| Weighted average of all age-classes | 15.8 | 28.9 | 55 |

## Forest Fires

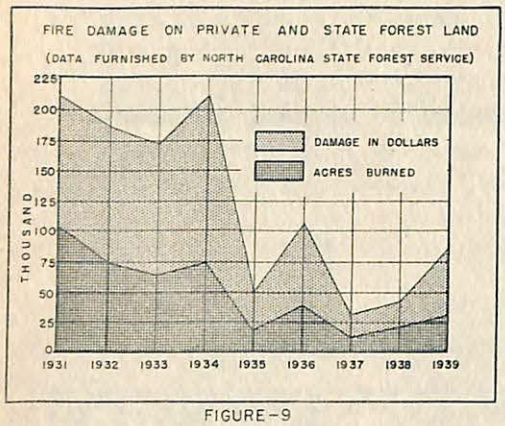


FIGURE-9

Forest fires are not so serious a problem in the Piedmont as in the Coastal Plain and Mountain regions of North Carolina. Although numerous ownerships tend to increase the fire hazard in some respects they also serve to break up the forest land into small scattered blocks in which fires can be localized. Furthermore most of the woodland is on farms where it provides the farm operators with fuelwood, fenceposts, building material, and commercial forest products. The intensive demand for these products provides considerable incentive for protecting timber stands from fire. In 1937-38 only 10 of the 35 counties in the unit were cooperating financially with the fire control division of the North Carolina State Forest Service. The beneficial effect of the State's fire control program extends throughout the unit, however, and since 1931 the annual loss from fire, both in acres and dollars, has been reduced by more than one-half in the entire unit (fig. 9).

At the time of the survey in 1937 there was no evidence of past forest fires on 65 percent of the forest area (table 6). By comparison, the effect of forest fires was noticeable on more than 80 percent of the forest land in the Southern Coastal Plain of North Carolina. Signs of previous fires, so light they caused no apparent damage, were evident on 21 percent of the area and light to medium fire damage was recorded on 14 percent. The upland hardwoods were burned more severely than any other type. Fire has been present on 44 percent of the type area, and light to medium damage has occurred on nearly half of the burned acreage. A higher proportionate area of the loblolly pine-hardwoods type is burned over than of the other two pine types. Less than one-fourth of the Virginia pine-hardwoods type has been subjected to fire and only three percent of it has suffered medium to heavy damage. Least affected by fire is the bottom-land hardwoods type. Only 9 percent of its area has been damaged by fire.

Table 6. - Degree of fire damage by forest type

| Degree of damage | Shortleaf pine-hardwoods | Loblolly pine-hardwoods | Virginia pine-hardwoods | Upland hardwoods | Bottom-land hardwoods | All types |
|---|---|---|---|---|---|---|
| | Percent of type area | | | | | |
| No fire | 66 | 62 | 76 | 56 | 82 | 65 |
| Present - no damage | 23 | 19 | 14 | 24 | 9 | 21 |
| Damage light | 9 | 14 | 7 | 16 | 5 | 11 |
| Damage medium | 2 | 5 | 2 | 4 | 3 | 3 |
| Damage heavy | Negl. | Negl. | 1 | Negl. | 1 | Negl. |
| Total | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |

## VOLUME OF THE FOREST RESOURCE

The 1937 inventory of the timber resource included the sound volume of all living trees 5.0 inches d.b.h. or larger. Dead trees were tallied but their volume is shown only as mortality drain in the tables showing comparisons of growth and drain. Estimates of the volume of sound wood are given in board feet, cords, and cubic feet. Volumes expressed in board feet include only the sawlog portion of saw-timber trees (pines and red cedar 9.0 inches d.b.h. and larger, hardwoods 13.0 inches d.b.h. and larger). Cordwood volumes (wood and bark) include the sawlog portion of all saw-timber trees, the cordwood material in the upper stems of pine and the upper stems and limbs of hardwood saw-timber trees, the sound stems of both pine and hardwood under-sawlog-size trees, and the sound volume in cull trees. Bark is omitted from cubic-foot volumes, otherwise the basis of estimate is the same as for cordwood.

The various species of hardwoods have been grouped together in rather broad classes in the following presentation of volume data. The red oaks include southern red oak, northern red oak, and swamp red oak; species which generally produce good quality material. The so-called inferior red oaks include black, scarlet, pin, water, and willow oaks. These species are not always of poor quality but in general produce a smaller proportion of the better grades of lumber. The white oaks are swamp chestnut and forked-leaf white oak. Usually these species are of good quality and are preferred for tight cooperage, furniture stock, and high-grade flooring. Where forked-leaf white oak occurs on the drier uplands and poorly-drained flats it is, however, often defective and of bad form. Post and chestnut oaks comprise the inferior white oak group. They frequent poor sites and normally do not compare in quality with swamp chestnut and forked-leaf white oaks. The hickory group consists chiefly of southern shagbark, pignut, and mockernut hickories. They are used, without distinction between species, for special products such as handles and picker sticks. The remaining hardwood species are placed in a single group -- other hardwoods. On a board-foot volume basis blackgum is most abundant, followed in descending order by maple, willow, elm, ash, beech, and birch. Of these, probably the greatest demand is for maple and ash.

### Board-foot Volume

An estimate of the volume is computed with three log rules - International $\frac{1}{4}$-inch, Scribner, and Doyle (table 7). In each case the volumes are net log scale, deduction having been made for material that would be left in the woods because of rot, crook, limbiness, and other defects and for loss at the mill caused by sweep and interior defects. The International $\frac{1}{4}$-inch rule, used exclusively for subsequent board-foot volume tabluations and statements in this report, approximates the amount of green lumber that can be sawed from the saw-timber trees. The Scribner rule gives a less satisfactory measure because it is based upon a diagram of the small end of the log and does not allow for taper. The Doyle rule is based on a formula and although widely used it is the least accurate. The timber in this unit will saw out about 70 percent more lumber than the Doyle rule indicates. This proportion is influenced by the distribution of tree diameters, however, and it will vary from stand to stand. More consistent results can be obtained with the International rule or with lumber tally measurement.

Table 7. - Net volume by the International ¼-inch, Scribner, and Doyle rules classified according to species-group, 1937

| Species-group | International* | Scribner | Doyle |
|---|---|---|---|
| | Thousand board feet | | |
| Pines: | | | |
| Shortleaf | 5,003,300 | 4,134,000 | 2,567,800 |
| Loblolly | 1,704,000 | 1,444,300 | 970,100 |
| Virginia | 910,400 | 750,900 | 439,800 |
| Other softwoods | 55,900 | 46,300 | 27,300 |
| Total softwoods | 7,673,600 | 6,375,500 | 4,005,000 |
| Hardwoods: | | | |
| Sweetgum | 371,800 | 335,500 | 260,500 |
| Yellowpoplar | 585,500 | 530,200 | 415,800 |
| Red oaks | 334,900 | 305,100 | 244,900 |
| Inferior red oaks | 429,800 | 390,000 | 306,400 |
| White oaks | 787,900 | 718,700 | 580,600 |
| Inferior white oaks | 178,200 | 160,400 | 124,300 |
| Hickory | 315,800 | 288,100 | 216,700 |
| Other hardwoods | 406,100 | 363,300 | 281,700 |
| Total hardwoods | 3,410,000 | 3,091,300 | 2,430,900 |
| Total all species | 11,083,600 | 9,466,800 | 6,435,900 |

*The scale by this rule approximates green lumber tally.

The 7.7 billion board feet of pine saw timber in this unit (table 8) is 28 percent of the pine volume in the State. Two-thirds of it is shortleaf pine, one-fifth is loblolly pine, and about one-tenth is Virginia pine. Redcedar makes up two-thirds of the "other softwood" volume, and the remainder is white pine and hemlock.

Old-growth stands contain 18 percent of the pine volume and undersawlog-size stands only 5 percent. Second-growth stands of sawlog-size are the important source of pine saw timber, containing over three-fourths of the total volume. About 4 billion board feet is in stands in which little, if any, cutting has taken place. These uncut pine stands occupy 20 percent of the total forest area and average 4,100 board feet of pine per acre. The second growth partly cut pine stands contain 1.7 billion board feet of pine, distributed over 14 percent of the forest area. Because part of their volume has been removed they average only 2,400 board feet of pine per acre.

The 3.4 billion board feet of hardwood saw timber in the Piedmont (table 8) is 24 percent of the hardwood volume in the State. In relation to the forest area involved there is less hardwood than in the Coastal Plain or Mountain regions. The volume is rather uniformly distributed among the species; forked-leaf white oak is most abundant, followed closely by yellowpoplar. The better-quality red and white oaks make up about one-third of the total volume. Most of the hardwood species are being used by the furniture industry but part of the volume is unsuitable for such use because of its poor quality.

Table 8. - Net volume by the International $\frac{1}{4}$-inch rule classified according to species-group and forest condition, 1937

| Species-group | Sawlog size | | | | Under sawlog size* | Total | Proportion of total |
|---|---|---|---|---|---|---|---|
| | Old growth | | Second growth | | | | |
| | Uncut | Partly cut | Uncut | Partly cut | | | |
| | Thousand board feet | | | | | | Percent |
| Pines: | | | | | | | |
| Shortleaf | 455,900 | 554,800 | 2,724,400 | 1,049,800 | 218,400 | 5,003,300 | 45.1 |
| Loblolly | 67,400 | 256,700 | 812,000 | 501,500 | 66,400 | 1,704,000 | 15.4 |
| Virginia | 13,700 | 20,400 | 640,000 | 180,100 | 56,200 | 910,400 | 8.2 |
| Other sftwds. | 4,800 | 3,100 | 21,600 | 7,600 | 18,800 | 55,900 | 0.5 |
| Total | 541,800 | 835,000 | 4,198,000 | 1,739,000 | 359,800 | 7,673,600 | 69.2 |
| Hardwoods: | | | | | | | |
| Sweetgum | 61,900 | 77,600 | 105,200 | 107,600 | 19,500 | 371,800 | 3.4 |
| Yellowpoplar | 54,300 | 104,100 | 280,700 | 131,800 | 14,600 | 585,500 | 5.3 |
| Red oaks | 44,000 | 110,800 | 95,000 | 59,800 | 25,300 | 334,900 | 3.0 |
| Inferior r.o. | 31,000 | 123,900 | 147,300 | 91,300 | 36,300 | 429,800 | 3.9 |
| White oaks | 118,400 | 313,400 | 202,800 | 106,800 | 46,500 | 787,900 | 7.1 |
| Inferior w.o. | 17,100 | 63,800 | 44,400 | 30,000 | 22,900 | 178,200 | 1.6 |
| Hickories | 46,600 | 88,800 | 86,100 | 57,900 | 36,400 | 315,800 | 2.8 |
| Other hdwds. | 59,700 | 97,200 | 140,800 | 79,700 | 28,700 | 406,100 | 3.7 |
| Total | 433,000 | 979,600 | 1,102,300 | 664,900 | 230,200 | 3,410,000 | 30.8 |
| Total all species | 974,800 | 1,814,600 | 5,300,300 | 2,403,900 | 590,000 | 11,083,600 | 100.0 |
| Percent of total | 8.8 | 16.4 | 47.8 | 21.7 | 5.3 | 100.0 | |

*Includes reproduction condition.

About 40 percent of the hardwood volume is in old-growth stands. All too often the upland old growth consists of poor-quality individuals, for nearly three-fourths of the old-growth volume is in stands that have been culled of the best trees. Species such as yellowpoplar, sweetgum, and the better-quality red and white oaks make up three-fifths of the volume; the inferior oaks, hickories, and other hardwoods comprise the remainder.

Sawlog-size second-growth stands contain 52 percent of the hardwood volume. Yellowpoplar and the white oaks are particularly abundant species in the uncut stands but where partial cutting has occurred they have been utilized more intensively than the other hardwood species. They constitute 44 percent of the uncut stand volume and only 36 percent of the partly-cut stand volume. This concentration of the cut in the better species causes the inferior red and white oaks to make up an increased proportion of the stand.

Seven percent of the hardwood board-foot volume is in under-sawlog-size stands. The saw-timber trees in these stands usually occur as scattered individuals and seldom provide enough concentrated volume for logging operations. Younger trees are constantly reaching sawlog size, however, and every year a small proportion of the under-sawlog-size stands acquires enough board-foot volume to be classified as sawlog size. A large part of the present saw-timber volume is concentrated in the white oaks, inferior red oaks, and hickories.

Volume by diameter-class: A high proportion of the saw timber in this unit is in small trees. Nearly 60 percent of the pine board-foot volume is in trees less than 13.0 inches d.b.h. and more than 60 percent of the hardwood volume is in trees less than 19.0 inches d.b.h. (fig. 10). Small trees are relatively more expensive to log and transport to the mill than large ones, and sawmills cannot produce as much lumber per day from small logs. Costs per thousand board feet are therefore higher and lumber values are lower because small trees usually yield lower grades and narrower widths. Although these small trees are not so profitable to manufacture on a per thousand foot basis they furnish the log sizes most usable in the small sawmills of the region and yield lumber grades for which there is the greatest demand. In practice, the effect of tree sizes is not always reflected in sawmill costs and returns because logging and hauling is often contracted out at a flat rate on a piece-work basis and the rough lumber is frequently sold without regard to grade.

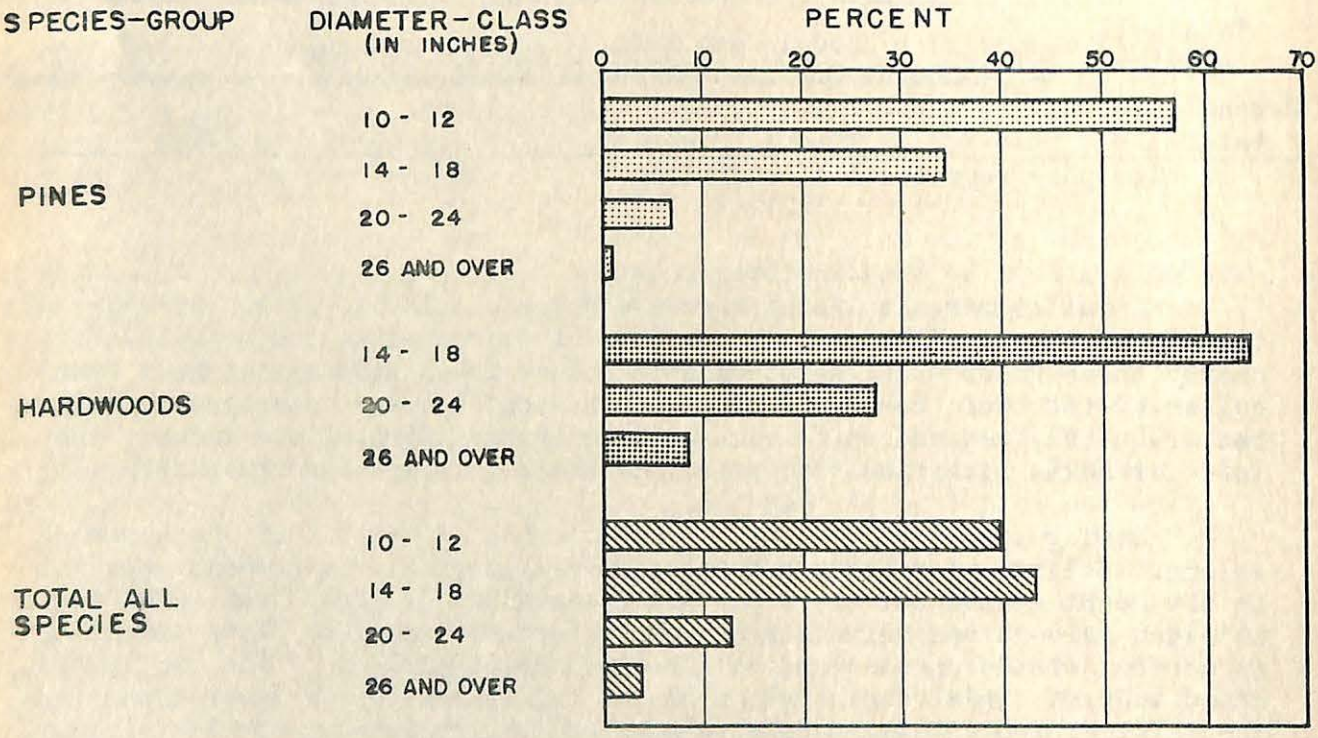



FIGURE 10 - DIAMETER DISTRIBUTION OF BOARD-FOOT VOLUME (INTERNATIONAL 1/4-IN. RULE)

Distribution by area and volume: It is probably more important to the sawmill operators of the Piedmont to have a heavy stand per acre, even in small trees, than it is to have a high proportion of the volume in large trees. Nearly all of the sawmills are small portable outfits. In most cases the mill is moved whenever the log haul must exceed one-half mile. Frequency of movement and moving expense depends upon the volume of merchantable timber per acre in the sawlog-size stands. Volume per acre also has a strong influence upon the amount that can be spent for logging roads and other improvements and in most cases is the factor controlling economic availability.

Volumes of 2,000 board feet per acre are considered a fair logging and milling chance in the Coastal Plain and Piedmont regions of North Carolina. In the sawlog-size stands of the pine and pine-hardwoods types of this unit 90 percent of the volume is in stands of 2,000 board feet or over, which occupy 70 percent of the type area (fig. 11). Nearly one-fourth of all the pine volume is on 7 percent of the pine area in stands per acre of 10,000 or more board feet. Slightly over half of the pine land supporting sawlog-size stands is stocked with 1,000 to 4,000 board feet per acre.

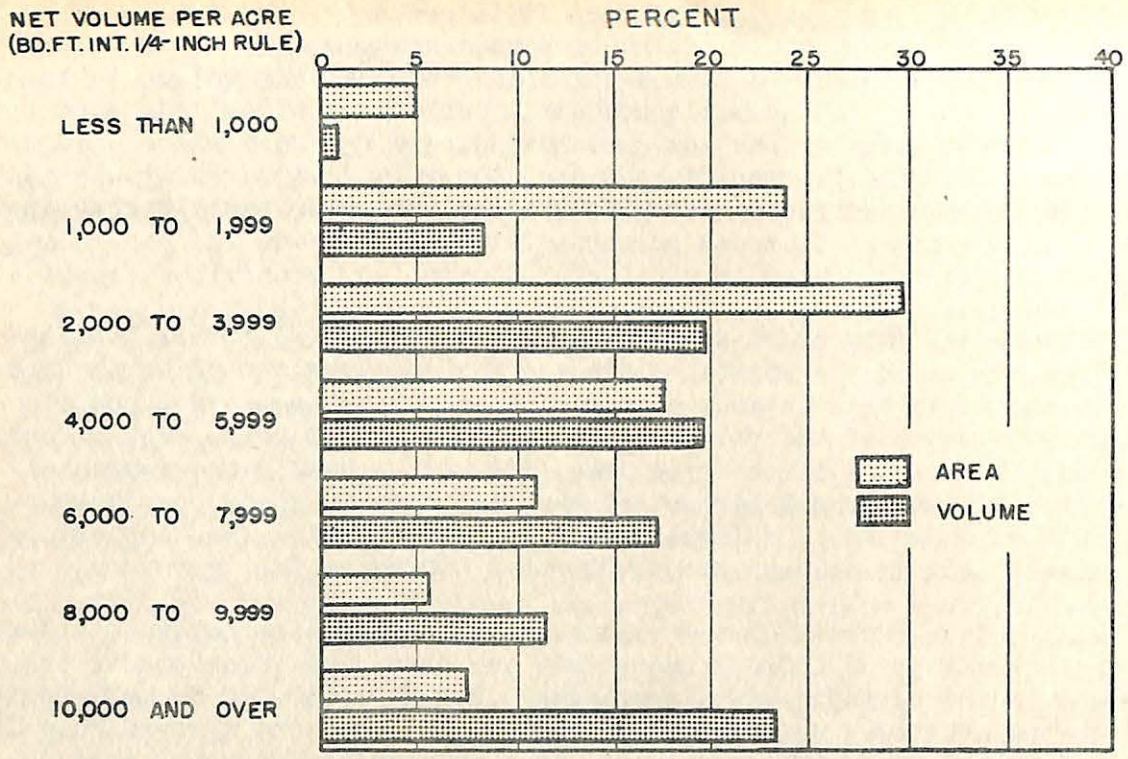
Eighty-four percent of the volume in the sawlog-size hardwood stands is in concentrations of 2,000 or more feet per acre, and these stands occupy 60 percent of the hardwood saw-timber area. Stands of 10,000 or more board feet per acre are found on only two percent of the area and contain only 10 percent of the hardwood volume. About two-thirds of the hardwood area is stocked with stands containing 1,000 to 4,000 board feet per acre.

Taking the sawlog-size stand as a whole, 89 percent of the board-foot volume is in stands of 2,000 or more feet per acre and these stands occupy 68 percent of the saw-timber acreage.

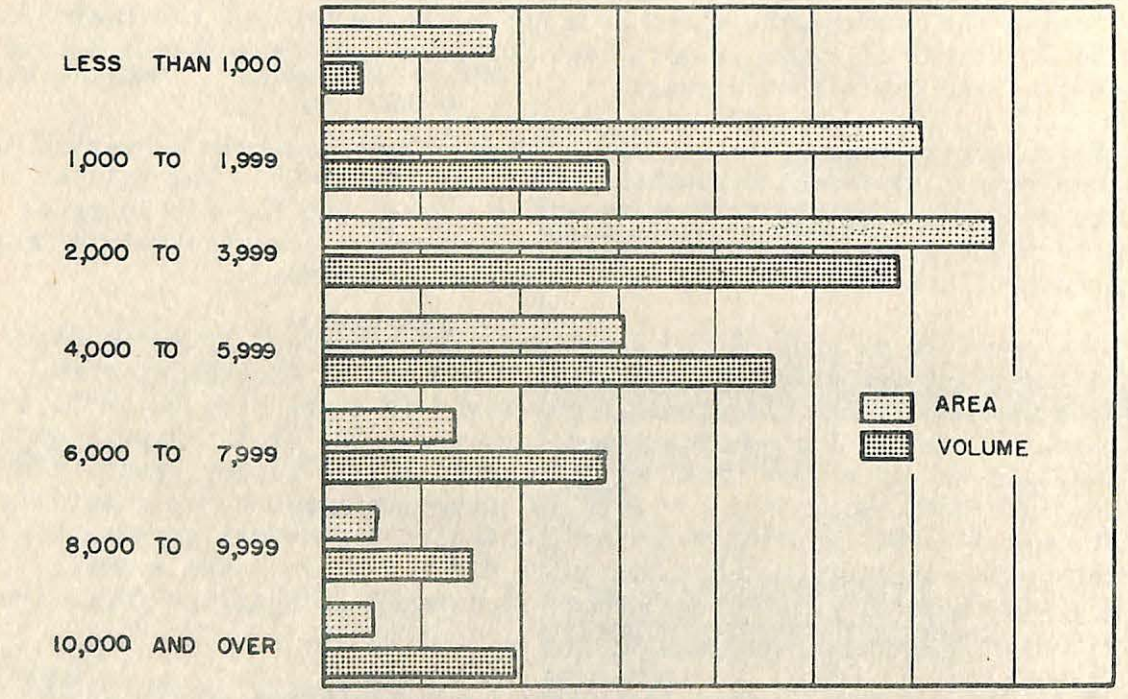
Volumes per acre: The total board-foot volume has been converted to a per-acre basis, by forest types and conditions (table 9). The values shown are seldom applicable to a few acres of timber but for a holding of several thousand acres they would indicate the average per-acre volume within a given type and condition with a fair degree of accuracy.

The per-acre volumes of the shortleaf pine-hardwoods type are especially interesting for this type occupies 47 percent of the forest area. The average volume of the old-growth uncut stand is impressive but relatively unimportant because of the small acreage involved. The second-growth uncut condition will supply a large part of the immediate saw-timber needs, and the volume of 4,800 board feet per acre is enough to provide for a satisfactory cut on most areas without removing the entire board-foot growing stock. The under-sawlog-size stands, occupying one million acres, have a small board-foot volume, but this will increase at a rapid rate as the young trees grow to sawlog size.

The upland hardwoods type, which occupies one-fourth of the forest area, has the smallest average volume per acre in all the sawlog-size conditions. The old-growth stands have a noticeably low volume and even the uncut second growth is deficient. Half of the type area supports under-sawlog-size stands. With careful management and reasonable use they should develop into well-stocked sawlog-size stands.




A.- PINE AND PINE-HARDWOOD TYPES




B.- HARDWOOD TYPES

FIGURE 11- DISTRIBUTION OF AREA AND BOARD-FOOT VOLUME IN THE SAWLOG-SIZE CONDITIONS, CLASSIFIED ACCORDING TO VOLUME OF SAW TIMBER PER ACRE

Table 9. - Average board-foot volume per acre classified according to forest type and forest condition, 1937

| Forest type | Sawlog size | | | | | Under sawlog size* | Weighted average of all conditions |
|---|---|---|---|---|---|---|---|
| | Old growth | | Second growth | | Weighted average | | |
| | Uncut | Partly cut | Uncut | Partly cut | | | |
| | Board feet** | | | | | | |
| Shortleaf pine-hdwds. | 12,180 | 5,780 | 4,810 | 2,820 | 4,430 | 250 | 2,530 |
| Loblolly pine-hdwds. | 10,480 | 9,520 | 5,320 | 3,200 | 4,710 | 210 | 2,710 |
| Virginia pine-hdwds. | 8,840 | 4,560 | 3,780 | 2,870 | 3,600 | 180 | 1,660 |
| Upland hardwoods | 5,600 | 3,810 | 2,400 | 1,810 | 2,910 | 300 | 1,570 |
| Bottom-land hdwds. | 10,450 | 5,820 | 3,000 | 2,940 | 4,490 | 300 | 2,900 |
| Average all types | 9,100 | 5,080 | 4,260 | 2,710 | 4,040 | 250 | 2,230 |

*Includes reproduction.
**Net volumes by the International $\frac{1}{4}$-inch rule.

## Cordwood Volume

Cordwood volumes are particularly significant because the forests of the Piedmont contain such a high proportion of young, small trees. This is evident from table 10, which shows the total volume in under-sawlog-size trees slightly exceeding the volume of sawlog material in saw-timber trees. In most other survey units of the southeast and south the sawlog volume predominates.

One-half of the cordwood volume, 36.7 million cords, is pine. The sawlog-size trees, including their upper stems, contain 62 percent of the volume, under-sawlog-size trees contain 34 percent, and cull trees only 4 percent. The proportion of the volume in small trees is much higher than in the pine forests of the Coastal Plain. Intensive use of saw timber has depleted the board-foot stand while land abandonment has paved the way for extensive stands of young second growth. Some of this young timber will die, some will be used for fuelwood or pulpwood, and a small proportion will be sawed into lumber prematurely, but the majority of it will contribute to the saw-timber growing stock.

Virginia pine makes up 7 percent of the total cordwood volume. As a rule this material is very poor in quality because the trees develop an excessive number of limbs. Clear lengths of stem-wood are rare and 15 percent of the total sound cordwood volume occurs in trees too rough to be used for anything but firewood. The proportionate volume in cull trees is greater than in any of the other pine species.

The hardwood volume, comprising one-half of the total cordwood, contains an exceptionally large proportion of under-sawlog-size trees and cull trees. Only 37 percent of the cordwood volume is contained in the stems and limbs of saw-timber trees, compared to 43 percent in the smaller sound

trees and 20 percent in the culls. The hickories and sweetgum have the largest proportionate volume in under-sawlog-size trees while the "other hardwoods" and red and white oaks contain most of the cull volume.

Table 10. - Net cordwood volume of all sound material, 1937

| Species-group | Sawlog-size trees | | Sound trees under sawlog size | Cull trees | Total | Proportion of total |
|---|---|---|---|---|---|---|
| | Sawlog material | Upper stems | | | | |
| | Cords | | | | | Percent |
| Pines: | | | | | | |
| Shortleaf | 12,255,900 | 2,931,400 | 8,114,400 | 617,700 | 23,919,400 | 33.0 |
| Loblolly | 4,053,500 | 895,800 | 2,167,000 | 146,900 | 7,263,200 | 10.0 |
| Virginia | 1,947,300 | 595,600 | 1,865,600 | 773,500 | 5,182,000 | 7.2 |
| Other softwoods | 130,000 | 6,900 | 217,200 | 7,500 | 361,600 | 0.5 |
| Total | 18,386,700 | 4,429,700 | 12,364,200 | 1,545,600 | 36,726,200 | 50.7 |
| Hardwoods: | | | | | | |
| Sweetgum | 927,800 | 502,100 | 1,675,600 | 395,000 | 3,500,500 | 4.8 |
| Yellowpoplar | 1,446,500 | 794,400 | 1,928,800 | 243,600 | 4,413,300 | 6.1 |
| Red oaks | 1,931,100 | 972,600 | 2,622,600 | 1,260,100 | 6,786,400 | 9.4 |
| White oaks | 2,462,100 | 1,241,900 | 4,099,400 | 1,506,600 | 9,310,000 | 12.8 |
| Hickories | 844,200 | 438,400 | 1,988,200 | 524,900 | 3,795,700 | 5.2 |
| Other hardwoods | 1,069,300 | 543,700 | 3,079,700 | 3,239,300 | 7,932,000 | 11.0 |
| Total | 8,681,000 | 4,493,100 | 15,394,300 | 7,169,500 | 35,737,900 | 49.3 |
| Total all species | 27,067,700 | 8,922,800 | 27,758,500 | 8,715,100 | 72,464,100 | 100.0 |
| Percent of total | 37.4 | 12.3 | 38.3 | 12.0 | 100.0 | |

Volume by diameter-class: In table 11 the cordwood volume includes the entire stand of sound trees 5.0 inches d.b.h. and larger but it does not include the 13.2 million cords in cull trees or upper stems and limbs of sawlog-size hardwoods. About three-fourths of the pine volume and two-thirds of the hardwood is in trees less than 13.0 inches d.b.h. The red oaks have the highest proportionate volume in large trees and Virginia pine has the lowest. Pines in the 10- and 12-inch class, a desirable pulpwood size, make up one-fourth of the total cordwood volume in sound trees.

Table 11. - Net cordwood volume of sound trees classified according to species-group and diameter-class, 1937

| Species-group | Tree diameter-class (inches) | | | | Total | Proportion of total |
|---|---|---|---|---|---|---|
| | 6 - 8 | 10 - 12 | 14 - 18 | 20 and over | | |
| | Cords (bark included) | | | | | Percent |
| Pines: | | | | | | |
| Shortleaf | 8,114,400 | 9,911,000 | 4,537,100 | 739,200 | 23,301,700 | 39.3 |
| Loblolly | 2,167,000 | 2,539,500 | 1,761,100 | 648,700 | 7,116,300 | 12.0 |
| Virginia | 1,865,600 | 1,803,000 | 724,200 | 15,700 | 4,408,500 | 7.5 |
| Other softwoods | 217,200 | 79,700 | 35,700 | 21,500 | 354,100 | 0.6 |
| Total | 12,364,200 | 14,333,200 | 7,058,100 | 1,425,100 | 35,180,600 | 59.4 |
| Hardwoods: | | | | | | |
| Sweetgum | 853,400 | 822,200 | 658,700 | 269,100 | 2,603,400 | 4.4 |
| Yellowpoplar | 794,100 | 1,134,700 | 988,600 | 457,900 | 3,375,300 | 5.7 |
| Red oaks | 1,135,200 | 1,487,400 | 1,245,200 | 685,900 | 4,553,700 | 7.7 |
| White oaks | 1,728,900 | 2,370,500 | 1,551,300 | 910,800 | 6,561,500 | 11.1 |
| Hickories | 841,900 | 1,146,300 | 670,300 | 173,900 | 2,832,400 | 4.8 |
| Other hardwoods | 1,716,700 | 1,337,700 | 787,900 | 306,700 | 4,149,000 | 6.9 |
| Total | 7,070,200 | 8,298,800 | 5,902,000 | 2,804,300 | 24,075,300 | 40.6 |
| Total all species | 19,434,400 | 22,632,000 | 12,960,100 | 4,229,400 | 59,255,900 | 100.0 |
| Percent of total | 32.8 | 38.2 | 21.9 | 7.1 | 100.0 | |

Volume per acre: The average stand of cordwood per acre, excluding cull trees and upper stems and limbs of sawlog-size hardwoods, is 11.9 cords (table 12). This is the average of all types and forest conditions, including the clear-cut areas and the reproduction and under-sawlog-size stands. The average stand in the Piedmont is about two cords less than the average stand in the Northern Coastal Plain and about two cords more than the average stand in the Southern Coastal Plain of North Carolina.

The sawlog-size stands average 18.4 cords per acre. The loblolly pine-hardwoods type has the largest average volumes per acre in the saw-timber conditions, although not greatly exceeding the shortleaf pine-hardwoods or bottom-land hardwoods types. Second-growth uncut stands in these pine types average about 23 cords per acre and occupy about one-third of the saw-timber area. The upland hardwoods type has the lowest average stand per acre in the sawlog-size conditions but exceeds the pine types in the under-sawlog-size conditions. Its average of 10 cords per acre represents the volume on one-fourth of all the forest land.

Table 12. - Average cordwood volume per acre, classified according to forest type and forest condition, 1937

| Forest type | Sawlog size | | | | | Under sawlog size* | Weighted average of all conditions |
|---|---|---|---|---|---|---|---|
| | Old growth | | Second growth | | Weighted average | | |
| | Uncut | Partly cut | Uncut | Partly cut | | | |
| | Cords | | | | | | |
| Shortleaf pine-hardwoods | 34.2 | 20.1 | 22.5 | 15.2 | 20.1 | 4.6 | 13.1 |
| Loblolly pine-hardwoods | 36.8 | 28.8 | 24.6 | 16.4 | 21.1 | 3.9 | 13.4 |
| Virginia pine-hardwoods | 28.0 | 15.7 | 17.9 | 12.8 | 16.6 | 3.4 | 9.1 |
| Upland hardwoods | 19.1 | 14.9 | 13.7 | 11.1 | 13.7 | 6.1 | 9.8 |
| Bottom-land hardwoods | 33.7 | 20.2 | 18.0 | 16.9 | 20.1 | 6.4 | 14.9 |
| Average all types | 27.9 | 18.1 | 20.5 | 14.5 | 18.4 | 4.8 | 11.9 |

*Includes reproduction and clear-cut conditions.

## Cubic-foot Volume

In table 13 the volume of sound wood in trees 5.0 inches d.b.h. and over, has been summarized in cubic feet because the cubic foot provides a more accurate measure of wood volume than either board feet or cords. The elimination of bark causes minor changes in the proportional distribution of the volume when compared to the cordwood estimates of table 10. Sound pine makes up 54 percent of the total cubic-foot stand, in contrast to 51 percent of the cordwood stand while sawlog material of both pine and hardwood comprise 40 percent of the total stand instead of 37 percent when measured in cords.

Table 13. - Net cubic-foot volume of all sound wood, without bark, 1937

| Species | Sawlog-size trees | | Sound trees under sawlog size | Cull trees | Total | Proportion of total |
|---|---|---|---|---|---|---|
| | Sawlog material | Upper stems | | | | |
| | Thousand cubic feet | | | | | Percent |
| Shortleaf pine | 888,010 | 210,280 | 549,000 | 43,670 | 1,690,960 | 35.1 |
| Loblolly pine | 290,780 | 63,420 | 141,290 | 10,240 | 505,730 | 10.5 |
| Virginia pine | 141,550 | 43,150 | 131,270 | 55,430 | 371,400 | 7.7 |
| Other softwoods | 9,860 | 500 | 16,060 | 560 | 26,980 | 0.6 |
| Sweetgum | 64,290 | 30,490 | 107,350 | 26,040 | 228,170 | 4.7 |
| Yellowpoplar | 96,670 | 46,450 | 122,810 | 15,840 | 281,770 | 5.8 |
| Oaks | 286,210 | 126,620 | 414,160 | 173,910 | 1,000,900 | 20.8 |
| Hickories | 56,350 | 25,660 | 127,190 | 34,010 | 243,210 | 5.0 |
| Other hardwoods | 71,550 | 31,880 | 195,940 | 171,140 | 470,510 | 9.8 |
| Total | 1,905,270 | 578,450 | 1,805,070 | 530,840 | 4,819,630 | 100.0 |
| Percent of total | 39.5 | 12.0 | 37.5 | 11.0 | 100.0 | |

## Poles

Trees sold for poles usually bring a higher price than those sold for sawlogs. For this reason an estimate has been made of the number of shortleaf and loblolly pine trees suitable for poles (table 14). An unusually small proportion of the pole stand will make poles 35 feet or over in length; only 7.7 percent compared to 15.7 percent in the Northern Coastal Plain of North Carolina. Also nearly twice as great a proportion of the poles in this unit occur in trees of the 7.0 to 8.9-inch d.b.h. class. There appears to be no pronounced concentration of pole timber in the Piedmont. Pole trees were recorded least frequently in Anson, Franklin, Rockingham, Union, and Wake, and most frequently in Durham, Granville, Orange, and Person Counties.

Table 14. - Total number of pine poles, classified according to length and diameter, 1937

| D.b.h. of trees (outside bark) | Pole length (feet) | | | | | Total | Proportion of total |
|---|---|---|---|---|---|---|---|
| | 20 | 25 | 30 | 35 | 40 or over | | |
| Inches | - - - - - - - - Thousand pieces - - - - - - - - | | | | | | Percent |
| 7.0 - 8.9 | 7,795 | 2,379 | 910 | -- | -- | 11,084 | 46.9 |
| 9.0 - 10.9 | 3,714 | 2,110 | 1,472 | 528 | 150 | 7,974 | 33.7 |
| 11.0 - 12.9 | 950 | 887 | 848 | 415 | 272 | 3,372 | 14.3 |
| 13.0 - 14.9 | 130 | 229 | 279 | 183 | 166 | 987 | 4.2 |
| 15.0 - 16.9 | -- | 43 | 63 | 57 | 60 | 223 | 0.9 |
| Total | 12,589 | 5,648 | 3,572 | 1,183 | 648 | 23,640 | 100.0 |
| Percent of total | 53.3 | 23.9 | 15.1 | 5.0 | 2.7 | 100.0 | |

## INCREMENT OF THE FOREST

Increment is the net volume of wood produced by the growing stock of the forest. The board-foot growing stock consists of all sound pine trees 9.0 inches d.b.h. and larger and all sound hardwood trees 13.0 inches d.b.h. and larger. The cubic-foot growing stock includes all sound trees at least 5.0 inches d.b.h. The 2- and 4-inch trees becoming 5.0 inches or more during the increment period are included in cubic-foot tabulations of increment and the under-sawlog-size pines and hardwoods that become saw timber are included in board-foot increment. Neither the volume in cull trees nor that in the upper stems and limbs of sawlog-size hardwoods is considered growing-stock material.

### The Interrelation of the Elements of Increment

Increment is the resultant of two opposing factors -- total growth and volume lost through mortality and decay. Total growth is composed of (1) the recruited volume created by small trees developing into merchantable sizes, (2) the volume added by growth to individual trees already of merchantable size, including growth on utilized trees up to the time of their removal from the stand. The effect of mortality and the two elements of total growth upon net board-foot and cubic-foot increment in the several forest conditions is illustrated in figure 12, where the total growth in each condition is represented by the 100 percent bar and mortality losses by the bar to the left of the zero line. Net increment is not shown directly but it is equivalent to total growth less mortality.

In both the pines and hardwoods a high proportion of the total growth is derived from the recruited volume. This is most noticeable in the under-sawlog-size stands, but recruited volume is also an important part of the total growth in the saw-timber conditions. About 56 percent of the total hardwood board-foot growth and 53 percent of the pine growth result from small trees growing into sawlog size. Compared to board-foot recruitment, the volume recruited into the cubic-foot stands makes up a smaller proportionate part of the total growth in practically all condition classes.

Mortality losses are proportionately greatest in the old-growth conditions. In the pine and hardwood saw timber, both old growth and second growth, the mortality loss is more than compensated by the volume recruited from the younger trees. The mortality in under-sawlog-size stands of both pine and hardwood is unusually low by comparison with similar stands in the Coastal Plain.

### Increment of the Total Stand

In 1937 the total growth of the forest growing stock was 769 million board feet and the volume lost because of mortality amounted to about 60 million feet. Net increment was, therefore, approximately 709 million board feet (table 15), of which 73 percent was pine and 27 percent was hardwood. About three-fourths of the increment developed in sawlog-size stands and one-fourth in stands under sawlog size. Eighteen percent of the hardwood increment and 6 percent of the pine accrued in the old-growth condition.

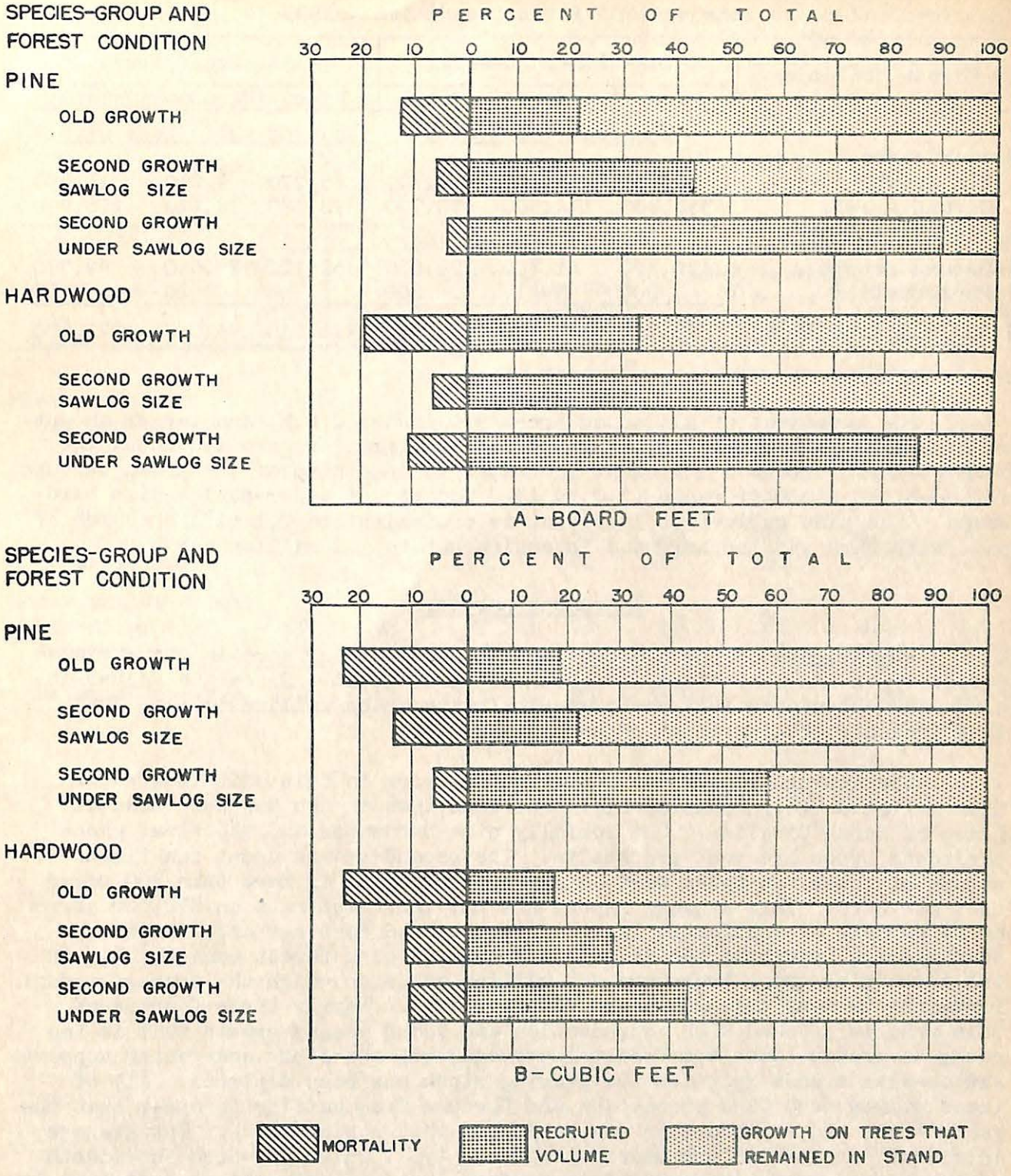

SPECIES-GROUP AND FOREST CONDITION
PINE
OLD GROWTH
SECOND GROWTH SAWLOG SIZE
SECOND GROWTH UNDER SAWLOG SIZE
HARDWOOD
OLD GROWTH
SECOND GROWTH SAWLOG SIZE
SECOND GROWTH UNDER SAWLOG SIZE
PERCENT OF TOTAL
30 20 10 0 10 20 30 40 50 60 70 80 90 100
A - BOARD FEET
SPECIES-GROUP AND FOREST CONDITION
PINE
OLD GROWTH
SECOND GROWTH SAWLOG SIZE
SECOND GROWTH UNDER SAWLOG SIZE
HARDWOOD
OLD GROWTH
SECOND GROWTH SAWLOG SIZE
SECOND GROWTH UNDER SAWLOG SIZE
PERCENT OF TOTAL
30 20 10 0 10 20 30 40 50 60 70 80 90 100
B - CUBIC FEET
MORTALITY
RECRUITED VOLUME
GROWTH ON TREES THAT REMAINED IN STAND

FIGURE 12-PROPORTIONAL DISTRIBUTION OF THE ELEMENTS OF NET INCREMENT, 1937

Table 15. - Net increment in board feet and cubic feet in the various forest conditions, 1937

| Forest condition | Saw-timber material | | | All sound trees | | |
|---|---|---|---|---|---|---|
| | Pine | Hardwood | Total | Pine | Hardwood | Total |
| | Thousand board feet | | | Thousand cubic feet (i.b.) | | |
| Sawlog size: | | | | | | |
| Old growth | 32,600 | 34,100 | 66,700 | 5,770 | 9,210 | 14,980 |
| Second growth | 356,200 | 114,500 | 470,700 | 78,580 | 38,210 | 116,790 |
| Under sawlog size: | | | | | | |
| Second growth | 130,300 | 41,300 | 171,600 | 62,120 | 27,650 | 89,770 |
| Reproduction | 200 | Negl. | 200 | 40 | 20 | 60 |
| Total all conditions | 519,300 | 189,900 | 709,200 | 146,510 | 75,090 | 221,600 |

The increment of all sound trees 5.0 inches d.b.h. and larger amounted to 222 million cubic feet. When these smaller trees are included, the proportion of hardwood increment increases to one-third of the total because of the wider diameter range (5.0 to 13.0 inches) of under-sawlog-size hardwoods. The pine cubic-foot increment is equivalent to 2.1 million cords of wood with bark and the hardwood is equivalent to 1.2 million cords.

## Increment per Acre

An estimate of the average annual increment per acre in the various forest types and conditions is presented in table 16. Since the values include the calculated full years growth in the trees utilized during 1937 they indicate the increment of uncut stands.

The average board-foot increment per acre in this unit is greater than in the Southern Coastal Plain but less than in the Northern Coastal Plain of North Carolina. The loblolly pine-hardwoods and shortleaf pine-hardwoods types are most productive. The second-growth uncut saw-timber stands of these two types have an average increment of more than 300 board feet per acre. This average represents the increment rate on 812,000 acres or 16 percent of the forest land. Three hundred feet per acre is better than average increment but it can be increased with forest management. In the three pine types there are 2.3 million acres on which the average annual increment is less than 200 board feet per acre. Nearly three-fourths of this area is stocked with reproduction and young second growth that is too young to produce much board-foot increment, but the other one-fourth supports sawlog-size stands in which the growing stock has been depleted. All of these stands need fire protection and freedom from cutting in order that the young trees and reproduction may replenish the growing stock. The average increment per acre in the upland hardwoods type, which occupies one-fourth of the forest land, is unsatisfactory in all conditions. It is deficient in quantity and also quality because part of the increment is in the less valuable species.

An average increment of .68 cords per acre for all forest land is unusually high, exceeding the increment in the Piedmont of South Carolina, Georgia, or Alabama. It is a result of growth upon the large volume of young trees which occur both as distinct age-classes and in mixture with older stems.

Table 16. - Average increment per acre classified according to forest condition and forest type, 1937

| Forest condition | Saw-timber material | | | | | | All sound trees in all types | |
|---|---|---|---|---|---|---|---|---|
| | Short-leaf pine-hdwds. | Lob-lolly pine-hdwds. | Virginia pine-hdwds. | Upland hdwds. | Bottom-land hdwds. | Average of all types | Including bark | Excluding bark |
| | Board feet | | | | | | Cords | Cu.ft. |
| Sawlog size: | | | | | | | | |
| Old growth: | | | | | | | | |
| Uncut | 235 | 202 | 173 | 112 | 209 | 178 | 0.48 | 33.4 |
| Partly cut | 160 | 264 | 125 | 101 | 154 | 138 | 0.48 | 32.9 |
| Second growth: | | | | | | | | |
| Uncut | 300 | 331 | 236 | 159 | 199 | 268 | 0.91 | 62.7 |
| Partly cut | 189 | 215 | 192 | 124 | 202 | 182 | 0.72 | 49.1 |
| Under sawlog size: | | | | | | | | |
| Second growth | 89 | 83 | 73 | 72 | 66 | 81 | 0.63 | 42.0 |
| Reproduction | 1 | 2 | 1 | -- | -- | 1 | Negl. | 0.3 |
| Weighted average | 172 | 181 | 131 | 98 | 142 | 149 | 0.68 | 46.0 |

## PRIMARY FOREST INDUSTRIES[4/]

About 1,660 primary wood-processing plants were utilizing the timber stands of the Piedmont in 1937. The lumber industry predominates, but numerous plants manufacture veneer, furniture dimension stock, cooperage, tobacco baskets, handles, shuttle blocks, excelsior, and shingles. In addition, a considerable quantity of crossties, poles, and fuelwood are cut as well as smaller amounts of pulpwood and extract wood. Altogether nearly 900 million board feet of saw timber were used and 4-3/4 million man-days of labor were expended.

### The Lumber Industry

In 1937 there were about 1,600 sawmills operating in the unit. The majority were small portable mills able to produce only a few thousand board feet per day under the most favorable conditions, as less than 30 mills had a daily cutting capacity of more than 10,000 feet. Most of the mills make rough lumber which is produced under contract for, or is sold direct to, concentration yards. These yards finish the lumber, sell some of it at retail to local consumers and the larger part at wholesale upon the general lumber market. The total cut of all the mills, including 168,000 sawn crossties, amounted to 624 million board feet, about 90 percent pine and 10 percent hardwood. Approximately 95 percent of the pine and 80 percent of the hardwood was cut from second-growth saw timber.

About 50 sawmills in 18 counties brought 34 million board feet of pine sawlogs and 5.3 million feet of hardwoods into the unit for lumber manufacture. Of the pine, about one half came from the Coastal Plain and one-fourth from the mountains of North Carolina, and the remaining one-fourth chiefly from Virginia. Only one-fifth of the hardwood was drawn from the Coastal Plain, three-fifths was brought from the mountains and one-fifth from Virginia and South Carolina. About five million board feet of pine sawlogs and one-fourth of a million feet of hardwoods were shipped out of the unit to sawmills in the Coastal Plain and two million feet of pine sawlogs from the Piedmont were used by mills in the mountain region. The movement of sawlogs into the unit exceeded the movement out by 32 million board feet.

Small portable mills: Almost 95 percent of the pine and hardwood lumber was produced by 1,572 small mills that cut less than 10,000 board feet per day. The average small mill cut 365,000 board feet during the year and operated about 80 days. Both the production and operating time vary widely between mills, however, because many are operated by farmers who cut lumber only in their spare time, while others are operated practically full-time by experienced lumbermen. Most of the mills buy stumpage, some do contract or custom sawing, and a very few operate in their own timber. Hardly any of these small mills buy logs delivered at the plant.

The typical mill employs four men in the woods and four in the plant. Frequently the same crew does both logging and milling. The mills are

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4/Based on data gathered in cooperation with the U. S. Bureau of the Census.

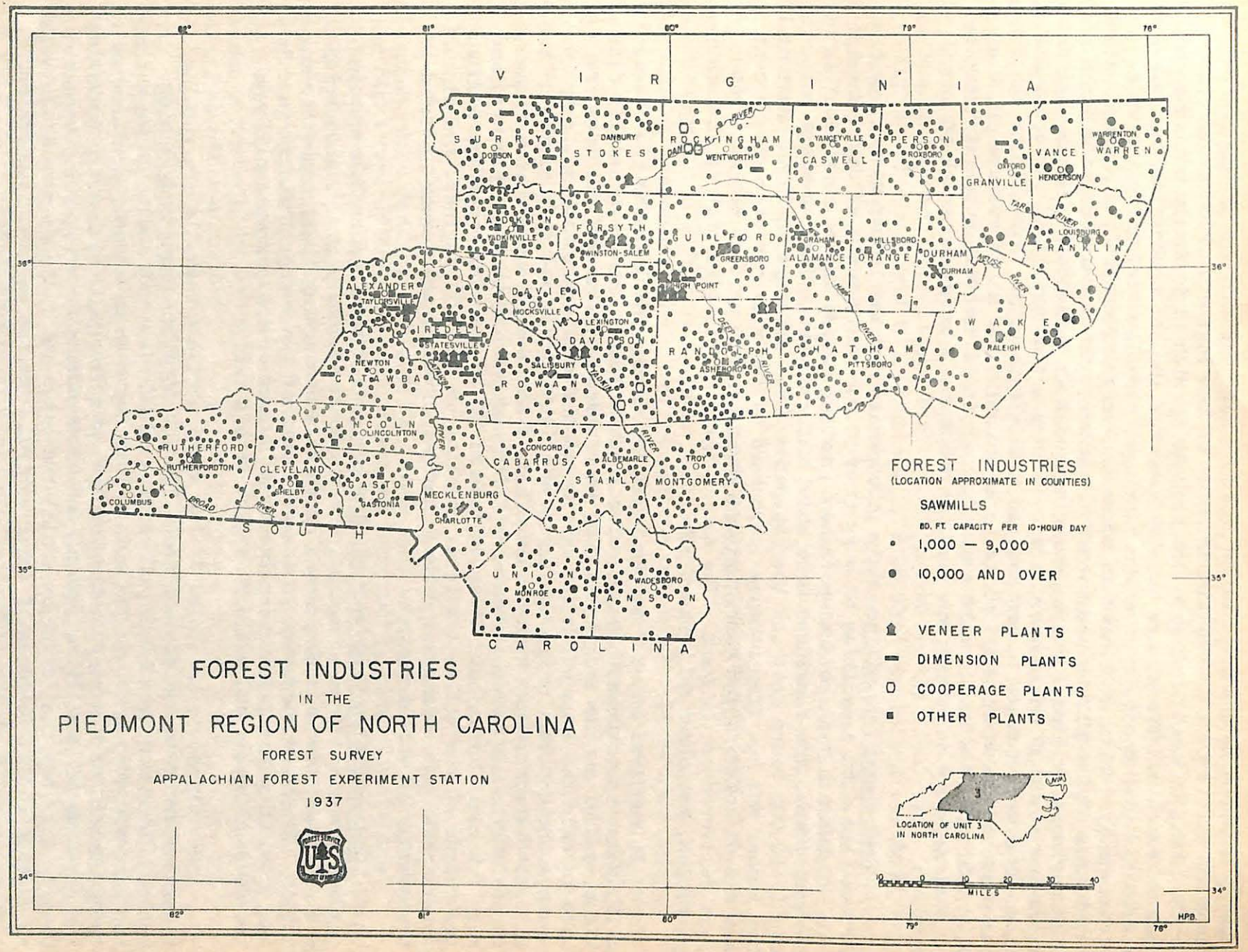
FOREST INDUSTRIES
IN THE
PIEDMONT REGION OF NORTH CAROLINA
FOREST SURVEY
APPALACHIAN FOREST EXPERIMENT STATION
1937
FOREST INDUSTRIES
(LOCATION APPROXIMATE IN COUNTIES)
SAWMILLS
BD. FT. CAPACITY PER 10-HOUR DAY
1,000 — 9,000
10,000 AND OVER
VENEER PLANTS
DIMENSION PLANTS
COOPERAGE PLANTS
OTHER PLANTS
LOCATION OF UNIT 3
IN NORTH CAROLINA
MILES
VIRGINIA
SOUTH CAROLINA
SURRY
STOKES
ROCKINGHAM
CASWELL
PERSON
GRANVILLE
VANCE
WARREN
FRANKLIN
YADKIN
FORSYTH
GUILFORD
ALAMANCE
ORANGE
DURHAM
WAKE
ALEXANDER
IREDELL
DAVIE
DAVIDSON
RANDOLPH
CHATHAM
CATAWBA
ROWAN
LINCOLN
RUTHERFORD
POLK
CLEVELAND
GASTON
MECKLENBURG
CABARRUS
STANLY
MONTGOMERY
UNION
ANSON
DANBURY
WENTWORTH
YANCEYVILLE
ROXBORO
OXFORD
HENDERSON
WARRENTON
LOUISBURG
GREENSBORO
HIGH POINT
WINSTON-SALEM
MOCKSVILLE
LEXINGTON
SALISBURY
STATESVILLE
TAYLORSVILLE
NEWTON
LINCOLNTON
RUTHERFORDTON
SHELBY
GASTONIA
CHARLOTTE
CONCORD
ALBEMARLE
TROY
ASHEBORO
PITTSBORO
HILLSBORO
GRAHAM
DURHAM
RALEIGH
LOUISBURG
MONROE
WADESBORO
COLUMBUS
DAN RIVER
YADKIN RIVER
CATAWBA RIVER
BROAD RIVER
DEEP RIVER
HAW RIVER
NEUSE RIVER
TAR RIVER
82°
81°
80°
79°
78°
38°
36°
35°
34°
HPB.

Figure 13

usually moved when the log haul approaches one-half mile in distance. Because the mills stay in the timber, many of the logs are skidded directly to the plant by team, but some are brought in with high-wheels pulled by a team or tractor. Trucks are usually used for the infrequent long hauls. As a rule the mill consists of a saw carriage, circular saw, and power unit. Occasionally a mill will have an edger and very infrequently a planer. About two-thirds of the plants use motors for power, either tractors, old automobile engines, or Diesel units averaging about 42 horsepower. Steam engines, averaging about 32 horsepower, are used in practically all of the other mills, although a very few mills are powered with electricity. Most all of the lumber produced by these small mills is sold unfinished at an average price of $10 to $15 per thousand, mill run. Much of it is "roofer" material but part of that sold to concentration yards is re-sawed into graded stock at the yard.

Semi-permanent mills: Only five percent of the lumber was cut by the 28 sawmills with capacities of more than 10,000 board feet per day. Nearly half of these mills are semi-permanent, having stayed in the same location several years, the remainder move about twice a year. Their average cut was 1,550,000 board feet and they operated about 170 days in 1937. Half of the lumber was cut from stumpage purchased by the mill operator, 40 percent was cut on contract for concentration yards, and 10 percent was cut from logs delivered on the yard. The cut of these mills, like that of the smaller portables, was about 90 percent pine.

It required about 7 men in the woods to provide logs for the average mill, which operated with 9 men. The woods and mill crews are usually distinct, and often the logging is done on contract. Teams and tractors are used to skid the logs which are carried to the more stationary mills by truck. The contract mills usually move to the timber and skid direct to the mill with tractors and high-wheels. All of the sawmills use circular saws, three-fourths use edgers, about one-fifth use cut-off saws and planers, and very few have dry-kilns. Steam engines of 50 to 100 horsepower are used in two-thirds of the mills, tractors, gasoline or fuel oil engines, and electric motors power the remainder. Almost three-fourths of the lumber produced by these mills is unfinished.

Concentration yards and planing mills: In this report both concentration yards and planing mills are considered secondary forest industries and no attempt is made to present exact data concerning their number or location. They are, however, an integral part of the lumber industry in this unit, bridging the gap between the rough lumber of the portable mill and the dressed lumber and millwork of the retail yard.

Approximately one-third of the small portable sawmills are cutting rough lumber under contract to about 70 concentration yards and planing mills. These concerns handle 50 percent of the pine and about 40 percent of the hardwood lumber cut in the unit. They serve as middlemen, providing a ready market for the rough lumber of the small mills, occasionally financing the purchase of sawmill equipment, and often advancing money for stumpage. Usually they buy the lumber on a mill-run basis and remanufacture it to sell on a grade basis. Because of their control over the small-mill operator they can exert a strong influence upon his cutting practices.

Monetary importance of sawmills: In terms of dollars the sawmill industry is small compared to textile or tobacco manufacturing. The money distributed is important nevertheless, because it provides a livelihood to several thousand workers and an increased income to many farmers, merchants, and equipment manufacturers. The following estimate of the value of wages, raw material, fuel, repairs and replacements, and product is based upon a sample of about 10 percent of the mills. The range of mills sampled extended from the small family-operated custom sawmill to the semi-permanent steam mill making dressed lumber and millwork. On this basis it is estimated the 1,600 sawmills in the unit paid 2.4 million dollars in wages to sawmill and woods workers. About half of this amount was paid by the mills cutting less than 500,000 board feet per year which comprise three-fourths of the mills in the unit. Slightly over 2.5 million dollars were given for stumpage and one-fourth of a million dollars for logs delivered at the mill yard. Fuel, chiefly gasoline and fuel oil, cost nearly $300,000. Approximately $400,000 was spent for repairs, new or used sawmill equipment, teams, motor trucks, and tractors. These expenditures, totaling nearly 6 million dollars, cover part of the costs incurred in producing lumber valued at about 8 million dollars. Total production costs would also include rent, taxes, interest, insurance, plant depreciation and profit margin.

## Other Forest Products

Veneer: The furniture factories of North Carolina require a large quantity of veneer and part of it is made by the veneer plants operating in this unit. Eighteen plants used 26.6 million board feet of hardwood veneer logs in 1937. About two-thirds of this volume was yellowpoplar, one-fourth was sweetgum, and the remainder was white oak, blackgum, walnut, maple, and sycamore. Approximately three-fourths of the veneer logs were cut from old-growth timber. The forests of the Piedmont supplied one-half of the veneer bolts, 12 percent came from the Coastal Plain, 30 percent came from South Carolina and the remainder from Virginia and Georgia. Practically all of the mills buy logs delivered at the mill yard.

In 1939 the average cost of delivered veneer bolts was $25.50 per thousand board feet and labor costs at the mill averaged about $21 per thousand board feet of consumption. Power was supplied by coal-fired steam engines and numerous electric motors at a cost, for coal and electricity, of $1.25 per thousand board feet utilized. The expenditures for equipment and repairs averaged $1.70 per thousand. These costs, which do not include plant depreciation, interest, taxes, or insurance, total about $50.00. On the average, a thousand board feet of bolts produced 9,000 square feet of veneer which sold for about $80.00. On this basis the 1937 production was worth two million dollars.

Hardwood dimension stock: In 1937 furniture dimension stock was made by 18 small plants. They used 6.8 million board feet of hardwood, chiefly hickory, white oak, and yellowpoplar, with some maple, birch, and ash. Three-fourths of the timber was second-growth. Practically all of the logs were cut within the unit and 90 percent of the log volume was purchased delivered at the yard.

The plants are usually small, seldom employing more than five men. The mill equipment is simple, consisting of a circular saw, rip saw, and cut-off saw. Electric motors are frequently used for power. Logs cost about $20.00 per thousand delivered at the mill or $8.00 to $10.00 on the stump. When manufactured into rough squares poplar, ash, birch, and black gum sell for about $40.00 to $60.00 per thousand board feet.

Cooperage: Both the tight and slack cooperage industries are represented in this unit. Two mills make tight staves using white oak and three mills make pine staves for tobacco hogsheads. Their total consumption was about one million board feet of logs. Three-fourths of the white oak was old-growth timber, but all of the pine was second growth. The white oak is purchased delivered at the tight stave mills, each of which are operated by 12 employees. The tobacco stave mills employ about 4 men in the woods and 4 at the plant.

Tobacco baskets: Yadkinville, in Yadkin County, is the center of tobacco basket production in North Carolina. In 1937 the three plants operating in the county made about 250,000 baskets. Hand-riven red and white oak splits are used for all of the basket except the rim, which is made of sawn lumber. The splits are made by farmers of the surrounding counties, who received about $45,000 for the five million splits made in 1937. About 1.5 million board feet of red and white oak logs were used for the splits and one-half a million board feet of lumber for the rims.

Handles and shuttle blocks: Six plants made handles and two made shuttle blocks in 1937. Plant capacities ranged from one-fourth cord to 10 cords per day and employees from 3 to 27 per mill. Altogether they used about 4,200 cords of hickory, poplar, dogwood, and maple. One handle plant made broom and mop handles exclusively from poplar and maple, the other five plants used second-growth hickory to make all kinds of tool and implement handles. The two shuttle block mills used dogwood entirely. In all of these plants the wood was purchased, delivered at the mill, from local farmers.

Shingles and excelsior: Approximately 700,000 shingles were made by the seven shingle mills operating in the unit in 1937. They used about 140,000 board feet of second-growth pine. Most of the mills are a permanent part of their community, staying at the same location year after year, making shingles on a custom basis for local use only. Each mill can make only five to ten thousand shingles per day and usually employs about four men.

The three excelsior plants used about 3,000 cords of second-growth pine and yellowpoplar in 1937. Yellowpoplar, however, makes up only a small proportion of the total consumption. The peeled wood is purchased by the cord, delivered at the mills which have a capacity of about five cords per day. The average mill employs 15 men.

Fuelwood: Only the lumber industry uses more wood than is consumed each year for fuel. The estimated total consumption of fuelwood in 1937 amounted to 2,600,000 cords, about two-thirds pine and one-third hardwoods. One-half of the wood was obtained from sawmill slabs, cull trees, and tops, and the rest from the sound-tree growing stock. Farmers used 63 percent of the fuelwood for heating and cooking and an additional 13 percent for curing

tobacco. Fifteen percent was used by rural families not on farms and 9 percent by urban dwellers, schools, and small commercial establishments. The average farm family used 13.8 cords of wood for domestic purposes and 2.7 cords for curing tobacco. The farmers obtain most of their wood from their own woodlands and consequently do not have to make cash expenditure for this fuel. The contribution of fuelwood to the farm income amounts to at least four million dollars, however, while the value of fuelwood used elsewhere approximates one million dollars.

Hewn crossties: About 576,000 hewn crossties were purchased in the unit by 17 public-carrier railroads in 1937. Only 1,400 of these ties were pine, practically all of the rest were white and red oak. Most of the hewn ties purchased were class 5 (7" x 9" x 8'6"). Hardwood ties of this size sold for 80 to 90 cents each delivered at the railroad in 1938. The smallest size, class 1 (6" x 6" x 8'6"), sold for 25 to 35 cents F.O.B. railroad. At 75 cents each the 575,000 hewn crossties brought the farmers and woodsworkers of the unit about $430,000.

Other products: Treating plants purchased most of the 16,000 pine poles and piles sold in this unit in 1937. Poles with an average top diameter of 8 inches and a length of 35 feet accounted for a high proportion of the production, while most of the piles were in 20- and 50-foot lengths.

About 14,000 cords of pine pulpwood were obtained from the Piedmont by pulp mills in Virginia and the Coastal Plain of North Carolina. Also 500 cords of distillation wood were sold in Tennessee. Wood used for miscellaneous farm construction and maintenance, in the form of poles, fence posts, and round timbers amounted to approximately 60,000 cords. All of these products, including poles and material used on farms, had a value at loading point of about $150,000 in 1937.

## Employment

The primary forest products industries furnished about 4.8 million man-days of employment in the mills and woods in 1937 (table 17). Seventeen percent, 829,000 man-days, was in the 1,662 forest products plants, as distinct from woods employment. The total number of men working in these plants was approximately 7,450. About 6,380 worked in sawmills, 720 worked in veneer plants, 90 in dimension stock mills, and the rest in handle, shuttle block, tobacco basket, cooperage, excelsior, and shingle mills. The wage rate in 1937 was not in excess of 25 cents per hour and at this rate the mill employees received about two million dollars in wages.

Eighty-three percent of the total employment was woods work, but four-fifths of this labor was expended in the production of fuelwood and other material for home use. Only 777,000 man-days were utilized in the production of sawlogs, bolts, basket splits, crossties, poles, and pulpwood. The total number of men employed is difficult to ascertain in this region where most of the woods work is done by farmers and small contractors. Part-time work is common and one full-time job may provide work for several different men during the course of a year. If each man worked 225 days per year, 3,450 men could produce the amount of wood used. It is probable, however, that about 6,000 individuals cut sawlogs for the sawmills and about 2,000

logged material for the other industries. The income of these 8,000 woods workers was about 1.5 million dollars in 1937.

Table 17. - Production and employment in the primary forest industries, 1937

| Commodity | Number of plants | Material cut in woods | Produced or used by plants | Employment provided | | |
|---|---|---|---|---|---|---|
| | | | | In woods | In plants | Total |
| | | Thousand board feet | | Thousand man-days* | | |
| Lumber | 1,600 | 592,400 | 624,300 | 592 | 678 | 1,270 |
| Veneer | 18 | 14,900 | 26,600 | 40 | 96 | 136 |
| Furniture dimension | 18 | 6,800 | 6,800 | 10 | 19 | 29 |
| Cooperage | 5 | 3,600 | 1,100 | 7 | 3 | 10 |
| Tobacco baskets | 3 | 1,500 | 1,500 | 15 | 11 | 26 |
| | | Thousand pieces | | | | |
| Poles and piles | -- | 16 | -- | 4 | -- | 4 |
| Hewn crossties | -- | 576 | -- | 81 | -- | 81 |
| | | Thousand cords | | | | |
| Fuelwood | -- | 2,592 | -- | 3,110 | -- | 3,110 |
| Misc. farm use | -- | 60 | -- | 66 | -- | 66 |
| Handles and shuttle blocks | 8 | 3 | 4 | 9 | 14 | 23 |
| Misc. mfg. products** | 10 | 17 | 3 | 19 | 8 | 27 |
| Total | 1,662 | -- | -- | 3,953 | 829 | 4,782 |

*Man-days equal 10 hours.

**Seven shingle mills, 3 excelsior mills, pulpwood and distillation wood.

## COMMODITY DRAIN

The commodity drain from the pine and hardwood sound-tree growing stock includes both the material utilized and the sound merchantable material left in felled trees. The drain on the saw-timber portion of the trees, including both the utilized and wasted portions, is expressed in board feet, whereas the volumes given in cubic feet and cords include drain on saw-timber material, upper stems of sawlog-size pines, and small trees ranging from 5.0 inches d.b.h. to sawlog size. The drain on hardwood tops is not included.

The drain upon saw-timber material amounted to 703 million board feet of pine and 183 million feet of hardwood in 1937 (table 18). About 690 million feet of pine were used by local forest industries and domestic consumers and 13 million board feet were shipped to sawmills in the Coastal Plain of North Carolina and cooperage and pulp mills in Virginia. Woods waste was negligible in the pine species. Nearly 172 million feet of the hardwood drain were used within the unit, slightly over one million board feet were taken to veneer plants in South Carolina, and about nine million board feet were left unutilized as woods waste.

About 85 percent of the pine and 60 percent of the hardwood cubic-foot drain was obtained from saw-timber trees. Pine trees under 9.0 inches d.b.h. were cut primarily for pulpwood, fuelwood, and miscellaneous farm use, while most of the hardwoods less than 13.0 inches were used for fuelwood. Old-growth stands provided 10 percent of both the pine and hardwood drain, second-growth sawlog-size stands 80 percent of the pine and 70 percent of the hardwood, and under-sawlog-size stands 10 percent of the pine and 20 percent of the hardwood. A high proportion of the drain upon the total sound-tree growing stock was caused by the local demand for fuelwood. About one-third of the pine and one-half of the hardwood was cut for this use.

Table 18. - Commodity drain from the sound-tree growing stock, 1937

| Commodity | Saw-timber material | | | All sound trees* | | |
|---|---|---|---|---|---|---|
| | Pine | Hardwood | Total | Pine | Hardwood | Total |
| | Thousand board feet | | | Thousand cubic feet | | |
| Lumber | 520,400 | 72,000 | 592,400 | 111,470 | 12,580 | 124,050 |
| Veneer | 100 | 16,200 | 16,300 | 30 | 2,830 | 2,860 |
| Furniture dimension | 100 | 7,400 | 7,500 | 20 | 1,300 | 1,320 |
| Handles and shuttle blocks | -- | 1,200 | 1,200 | -- | 230 | 230 |
| Cooperage | 3,000 | 700 | 3,700 | 640 | 120 | 760 |
| Tobacco baskets | -- | 1,700 | 1,700 | -- | 290 | 290 |
| Poles and piles | 1,900 | -- | 1,900 | 410 | -- | 410 |
| Crossties | 100 | 37,400 | 37,500 | 20 | 6,530 | 6,550 |
| Fuelwood | 170,000 | 43,600 | 213,600 | 61,030 | 27,420 | 88,450 |
| Misc. farm use | 3,800 | 2,300 | 6,100 | 2,150 | 1,070 | 3,220 |
| Misc. mfg. products | 4,000 | 200 | 4,200 | 1,170 | 50 | 1,220 |
| Total | 703,400 | 182,700 | 886,100 | 176,940 | 52,420 | 229,360 |

*Total drain from growing stock expressed in cords of wood with bark: 2,474,000 of pine; 811,100 of hardwood.

## COMPARISON OF INCREMENT WITH COMMODITY DRAIN

To be continuously productive a forest must grow an equal or greater amount of wood than is removed through natural and artificial causes. Otherwise the forest will be gradually depleted and the dependent industries and population will lack needed raw material. Both the natural and man-caused drain upon the forest fluctuates from year to year with changing conditions. Increment and drain comparisons for a single year are, therefore, unreliable for predicting long-time trends in the forest situation. A surplus of increment over drain does not, of itself, imply that the cut can be correspondingly increased. Conversely, when the drain exceeds the increment there is not always cause for alarm because the excessive cut may be temporary or there may be a large reserve of young timber just coming into production. Conditions within each survey unit must be judged by other factors than end figures in a comparison of increment and drain.

### Comparison in Board Feet

The pine growing stock decreased 184 million board feet in 1937 (table 19). Total growth was less than commodity drain and even the elimination of all mortality losses through fire protection and intensive utilization would still leave drain greater than net increment. Along with the reduction in growing stock there was a continuous replacement of the older and larger trees with young second-growth of minimum saw-timber size.

Table 19. - Comparison between increment and drain of saw-timber material, 1937

| Item | Pine | Hardwood | Total |
|---|---|---|---|
| | - - - - - Thousand board feet - - - - - | | |
| Net growing stock, Jan. 1, 1937 | 7,673,600 | 3,410,000 | 11,083,600 |
| Growth, 1937 | 557,000 | 211,700 | 768,700 |
| Mortality, 1937 | 37,800 | 21,700 | 59,500 |
| Net increment, 1937 | 519,200 | 190,000 | 709,200 |
| Commodity drain, 1937 | 703,400 | 182,700 | 886,100 |
| Net change in growing stock, 1937 | -184,200 | +7,300 | -176,900 |
| Net growing stock, Jan. 1, 1938 | 7,489,400 | 3,417,300 | 10,906,700 |

The pine drain in the old-growth condition was 2.7 times the increment and the drain in second-growth saw-timber was 1.7 times the increment. Only in the under-sawlog-size stands was increment greater than saw-timber drain, exceeding it five to one, but this surplus was not great enough to compensate for the over-cut in the saw-timber conditions. Volume recruited from these under-sawlog-size stands and from young trees in saw-timber stands amounted to one-half of the total growth. The diameter distribution of the

young trees in this unit does not indicate any appreciable increase in the amount of recruited volume and the pine board-foot growing stock will continue to decrease unless the commodity drain is reduced by at least one-fourth.

The slight increase in the hardwood board-foot growing stock is inconclusive. It shows the board-foot drain was less than the increment but gives no indication of the situation within species-groups. For example, about 75 percent of the commodity drain was red and white oak, 15 percent was yellowpoplar, 5 percent was sweetgum and blackgum, and 5 percent was hickory, maple, ash, birch, and sycamore. Increment was not determined for individual species but estimates of its distribution are as follows: red and white oaks 55 percent, sweetgum and blackgum 15 percent, yellowpoplar 20 percent, and miscellaneous hardwoods 10 percent. Because the volumes of increment and drain are approximately equal it is apparent the increment of red and white oak was insufficient to meet drain requirements while the increment of the other species-groups exceeded drain. Even with a surplus of increment yellowpoplar may not be producing enough high-quality material for the veneer industry.

## Comparison in Cubic Feet

Including the increment and drain upon the under-sawlog-size trees does not change the situation materially for the growing stock of sound pine trees, 5.0 inches d.b.h. and larger, decreased by 30 million cubic feet and the hardwood growing stock increased by nearly 23 million cubic feet (table 20).

Table 20. - Comparison between increment and drain of all sound material, 1937

| Item | Pine | Hardwood | Total |
|---|---|---|---|
| | - - Thousand cubic feet (i.b.) - - | | |
| Net growing stock, Jan. 1, 1937 | 2,485,170 | 1,542,520 | 4,027,690 |
| Growth, 1937 | 166,430 | 86,280 | 252,710 |
| Mortality, 1937 | 19,920 | 11,190 | 31,110 |
| Net increment, 1937 | 146,510 | 75,090 | 221,600 |
| Commodity drain, 1937 | 176,940 | 52,420 | 229,360 |
| Net change in growing stock, 1937 | -30,430 | +22,670 | -7,760 |
| Net growing stock, Jan. 1, 1938 | 2,454,740 | 1,565,190 | 4,019,930 |

In table 21 the change in growing stock values of table 20 have been broken down to show in which forest conditions and tree-sizes the losses and gains have occurred. There was a loss in volume of both small and large pines in the saw-timber conditions and a gain throughout the diameter range in the under-sawlog-size condition. Pine trees less than 9.0 inches in diameter increased by only 6.5 million cubic feet while saw-timber trees decreased nearly 6 times this amount. The volume of hardwoods below saw-timber size increased in all conditions. Although the total volume of hardwood saw-timber material is increasing it is decreasing in the second-growth sawlog-size stands where it is commercially important.

Table 21. - Change in growing stock by forest conditions, 1937

| Forest condition | Pine trees | | | Hardwood trees | | |
|---|---|---|---|---|---|---|
| | 5.0 - 8.9 inches d.b.h. | 9.0 inches d.b.h. and larger | Total | 5.0 - 12.9 inches d.b.h. | 13.0 inches d.b.h. and larger | Total |
| | - - M cu.ft. (i.b.) - - | | | - - M cu.ft. (i.b.) - - | | |
| Old growth | -750 | -12,240 | -12,990 | +3,000 | +850 | +3,850 |
| Second growth: | | | | | | |
| Sawlog size | -7,680 | -56,180 | -63,860 | +7,130 | -4,920 | +2,210 |
| Under sawlog size | +14,960 | +31,460 | +46,420 | +8,220 | +8,390 | +16,610 |
| Total all conditions | +6,530 | -36,960 | -30,430 | +18,350 | +4,320 | +22,670 |

## Comparison in Cords

In figure 14 the total growth, mortality and commodity drain, and change in growing stock is presented for the pines and hardwoods by forest condition. The situation parallels that previously given in cubic feet. The net result is a loss of 371,000 cords in the pine growing stock and an increase of 366,000 cords in the hardwood stand.

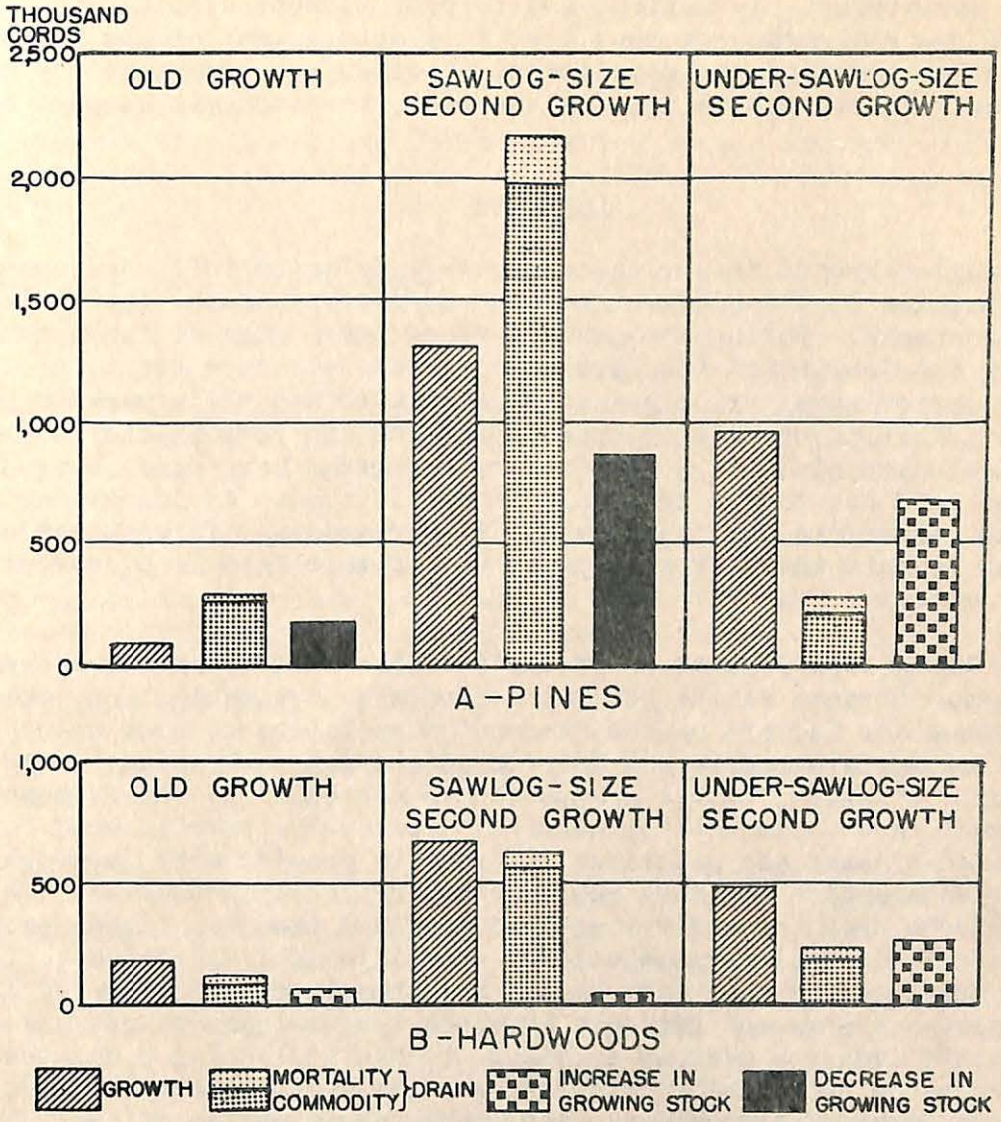


FIGURE 14-COMPARISON OF GROWTH WITH MORTALITY AND COMMODITY DRAIN BY FOREST CONDITIONS, 1937

## FOREST PROBLEMS AND REMEDIAL MEASURES

The forest problems of the Piedmont are essentially those concerned with land use, forest production, and forest products utilization. The objective of remedial measures should be full development of the forest resource, in harmony with the development of other resources, to the end that forest land will contribute its full share to the economic support of the region.

### Land Use

Changing trends in agriculture have a definite influence upon the forest situation in the Piedmont because 85 percent of the forest land is in farm ownership. During the past 35 years the number of farms has increased by one-fourth and the farm acreage has decreased about one-tenth. Yields of agricultural crops per acre have increased while markets have decreased. This is especially true of tobacco and cotton, the two most important crops in this unit. Crop control programs have also changed the pattern of land use toward less land in cultivation. An increasing amount of land is, therefore, becoming available for grazing, forests, or other uses. How to make the most productive use of this land is a problem of vital importance.

Existing deficiencies in products of the land afford an approach to the problem. Because of the general dependence upon cotton and tobacco for a cash income the farmers of the Piedmont have failed to grow enough vegetables, fruit, grain, meat, and dairy products for the rapidly increasing population. Likewise, timber production is not equal to the consumption of the numerous forest products industries. Obviously there is need for a reorganization of land use practices in order to provide more farm produce for local consumption and more wood for use by local industries. Good farm land should be used for agriculture and marginal land for timber production. The land in individual farms should be classified and allocated to its best use, and practices on each farm should be harmonized with those of the neighborhood, county, and region. Probably the best way of obtaining a comprehensive land-use plan is by means of county planning committees similar to those now functioning in a few counties of the State. The United States Department of Agriculture aids in the organization of these committees and provides advice and assistance to the various action programs. With a definite land use plan for each county of the Piedmont more efficient production of farm and forest crops would be facilitated.

### Forest Production

Irrespective of any possible changes in the forest area through improvements in land use there still exists the problem of increasing forest production to provide for the needs of local users. This can be accomplished through (1) more intensive fire protection, (2) improvement in the quality and quantity of the growing stock, (3) management practices designed to cope with hardwood invasion, and (4) a more intensive farm forestry program.

Fire protection: Forest fires damage the standing timber and serve as a strong deterrent to the practice of forestry, thus reducing forest productivity. Fires are a less serious problem in the Piedmont than in other parts of the State but there is still the necessity to reduce fire losses. In the 1937-38 season only one-third of the forest land was under organized protection. Intensive protection may not be economically justifiable in a few of the most agricultural counties but in general the fire control division of the North Carolina State Forest Service should provide protection to the farm woodlands of the Piedmont as rapidly as the necessary funds can be obtained.

Improvement of growing stock: For greater productivity the volume of growing stock per acre should be increased and for greater financial returns the quality of the growing stock should be improved. Practical forest management will be required to correct these deficiencies. In general this management should attempt to increase the total quantity of pine and hardwood growing stock by at least one-third, to develop a greater proportion of the pine volume in large trees, and to increase the yield of high-quality hardwoods.

Planting will be necessary on certain areas, thinning on others. Improvement cuttings should be made in both pine and hardwood stands to remove the slow-growing, badly-formed, poor-risk trees. Virginia pine should be cut along with shortleaf pine to avoid reseeding the land to this less valuable species. A greater proportion of the fuelwood should be cut from poor-quality hardwoods and from the tops of trees felled for other uses. Premature cutting of young pines should be stopped and part of the annual increment of both pines and hardwoods should be left unutilized to build up the growing stock.

Farmers will be largely responsible for these improvements because they own most of the forest land. With proper guidance they can go a long way in developing the forest stands of the unit. Most of them live near their small forest tracts and in their spare time they can cut cull material usable on the farm for fuelwood, fence posts, and rough building material. Improvement of the growing stock should be facilitated under these conditions.

Hardwood invasion: The pine species are the chief support of the present lumber industry in the Piedmont. Most of the pine is growing upon land that would normally support a climax hardwood type. Evidence points toward a gradual replacement of the pines by the hardwoods, which, if extensive, will eventually greatly reduce the importance of the pine lumber industry.

Now is the time to recognize this threat of hardwood invasion and to start working out appropriate management policies. To date there is no concensus of opinion among foresters in regard to the best way to manage the pine forests of the Piedmont. Some advocate cleanings in young pine-hardwood stands to release pine crop trees from hardwood competition and heavy cutting of mature pine stands with dependence upon seed trees for reseeding the land to pine. Others favor a system of selective cutting similar to that practiced in Arkansas, Alabama, and other states of the Deep South. In either case the problem of hardwood utilization ranks high in importance.

Obviously it is beyond the scope of the Forest Survey to work out the answers to the many silvicultural and utilization problems. Sound recommendations cannot be made until comprehensive research is initiated and followed through by forest management specialists.

Farm forestry: The attainment of improved forest practices and increased forest production throughout the Piedmont depends in a large measure upon the cooperation of the farm operators. In the past many farmers have not appreciated the benefit to be derived from systematic cropping of their farm woodlands and forest values have been dissipated. Activities of the public forestry agencies have, of financial necessity, been rather extensive in character and as a result only a small proportion of the farmers have received help on their individual forest problems. The services now provided by public agencies both State and Federal, should be intensified and new services should be provided.

Specifically, the following forms of public assistance would contribute materially to the development of farm forestry in the Piedmont: (1) a county forester organization working in individual or groups of counties through established State and Federal extension systems, (2) a wide application of the provisions of the Cooperative Farm Forestry Act, which has as an objective the intensive development of the farm woodland into a productive unit of the farm, (3) forest credit supplementing that now available from Federal Land Banks, and (4) financial provision for more adequate fire protection and an enlarged tree planting program.

## Forest Products Utilization

The need for developing the general utility of wood is fully as great as the need for increasing forest production. In the Piedmont the problem is not one of increasing the total consumption of wood, rather it is one of making adjustments in wood utilization practices. Consideration should be given to the problems presented by the portable sawmills, to the development of uses for low-grade hardwoods, and to more orderly marketing of forest products.

Portable sawmills: No other area in the southeast has a greater concentration of portable sawmills. In fact, the wood requirement of the great number of mills operating in 1937 greatly exceeded the growth capacity of the forest. In order to achieve a balance between growth and drain it will be necessary to reduce the number of mills or their total cut.

Part of the mills cut lumber for farm maintenance, part are custom mills sawing lumber on a fee basis for local use, but the majority are commercial mills sawing rough lumber for concentration yards. The farm and custom mills fill an important place in their communities, producing low-cost building material from home-grown timber. The commercial mills provide convenient markets for saw timber, widely-distributed employment, and a workable system of utilizing timber volumes held in small scattered stands. As operated at present, however, they constitute a serious obstacle to efficient forest production and utilization because they cut the young timber before it is financially mature and usually leave the cut-over stand in poor condition for future growth.

There are several ways of improving small mill practices. One of these is through an approach to the land owners. Intensive advice and assistance, as mentioned previously, should result in better forestry and more owner-control of cutting practices. Convincing the operators of concentration yards and planing mills that good forest practice by their contributing sawmills will ultimately benefit all concerned offers another solution. The producers of 40 percent of the lumber could be reached through only 30 of the largest concentration yards and lumber companies. One of the most effective ways would be public regulation of cutting practices. If found practicable this method would prevent deterioration of the forest, would protect the land owner, would assure a more stable supply of saw timber for industrial use, and would reduce resource competition between forest products industries.

Low-grade hardwoods: A high proportion of the hardwood volume in the Piedmont consists of inferior species and small, poorly-formed trees of the preferred species. Furthermore, the volume of this low-grade material is constantly increasing because the forest industries concentrate their drain upon pine and upon the best-quality oak and yellowpoplar.

Industrial product research is needed to develop new and large-scale uses for these low-grade hardwoods. Part of this research should be done at the Forest Products Laboratory of the Forest Service and part by commercial operators. The Laboratory is well equipped to develop products of wood conversion while local forest industrial plants should attempt to increase the variety of products manufactured from wood in its natural form.

Greater progress in the utilization of hardwoods might result if centralized plants were established to manufacture a variety of hardwood products. Dimension stock, handles, skis, shuttles, picker sticks, spools, buttons, cooperage, wooden dishes, and similar items could be produced in one plant with economies in manufacturing costs, with better utilization of grades and species, and with greater refinement of the product. Having more financial resources, better equipment, and more direct access to markets than do single-product mills these centralized plants should be in a better position to expand the use of all grades of hardwood.

Marketing of forest products: Most of the timber used by the forest industries in the Piedmont is obtained from farm woodlands and is purchased delivered at the mill or as standing timber. Very little material is sold by grade, although the veneer industry recognizes two classes of veneer blocks. Wood delivered at the plants is sold at a price established by the mill operator. The farmers have little bargaining power and usually must accept the price offered. The portable mills usually buy standing timber for a lump sum, a method which often places the farmer at a disadvantage because of his ignorance of timber volumes and values. This method also contributes to the deterioration of farm woodlands because the portable mills generally cut trees as small as 6 or 8 inches in diameter.

The farmers cannot grow timber on a sound basis under such marketing conditions. County foresters could effect some improvement by giving advice in timber estimating, cutting methods, log grading, timber values, and market opportunities. Improvement is also possible through the formation of cooperative marketing associations for the systematic sale of farm forest

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products. The purpose of cooperative action should be better management of forest land, better prices by offering graded material in bulk lots, protection to the small producer, and lower costs of distribution. These cooperatives should not attempt to be price-fixing associations nor should they necessarily eliminate the private middlemen such as the concentration yard operators. There is opportunity for the harmonious integration of forest cooperative activities with private mill operations for mutual benefit, but in case this fails the cooperatives should process their forest products in their own plants. Because cooperatives are simple in theory but rather complex in practice they should, at their inception, receive the advice and leadership of publicly employed foresters.

## REVIEW OF THE REPORT

The Piedmont of North Carolina has a diversified economy. It leads the nation in the production of textiles and cigarettes and is the center of furniture manufacture in the South. Agriculture is important and extensive as the products from the 120,000 farms were valued at 85 million dollars in 1937. About one-half of the Piedmont is forested and no equal area in the South contains so many wood-using plants.

The forests, which occupy nearly five million acres, are 85 percent in farm ownership. Shortleaf pine is the most abundant species, making up two-fifths of the total cubic-foot volume. Pine types occupy 72 percent of the forest area, upland hardwoods 24 percent, and bottom-land hardwoods only 4 percent. About 90 percent of the forest is second growth. Slightly over one-half of the forest land supports sawlog-size stands, the remainder is stocked with young second growth.

The total saw-timber volume is 11 billion board feet, about seven-tenths pine and three-tenths hardwood. There are 72.5 million standard cords of wood with bark or 4.8 billion cubic feet of wood only.

Increment amounted to 709 million board feet, 3.3 million cords, or 222 million cubic feet. The average annual increment per acre was 149 board feet of saw timber, or seven-tenths of a cord of all sound material.

About 1,660 primary forest industrial plants operated in the Piedmont in 1937. There were 1,600 sawmills, 18 veneer plants, 18 furniture dimension plants, 6 handle plants, 7 shingle mills, 5 cooperage plants, 3 excelsior mills, 3 tobacco basket factories, and 2 shuttle block mills.

The sawmills used about 624 million board feet of sawlogs and the veneer plants about 27 million board feet. About 2.6 million cords of fuelwood were cut. The utilization of the forest resource provided 4-3/4 million man-days of employment divided among approximately 15,000 workers.

The total commodity drain was 886 million board feet of saw timber or 229 million cubic feet of all sound material. Drain upon the pine species exceeded increment by 184 million board feet but the hardwood increment exceeded drain by 7 million board feet. The total growing stock of the forest decreased by 8 million cubic feet.

The forest situation is not satisfactory in the Piedmont. The pine and better-quality hardwood timber is being cut faster than it is growing and the quantity of low-grade hardwood is increasing. Portable sawmills dominate the lumber industry and their cutting practices are detrimental to the future productivity of the forest. Measures for improvement should include adjustments in land use, more intensive fire protection, better forest management practices, a more intensive farm forestry program, greater control of small mill cutting practices, more efficient utilization of low-grade hardwoods, and cooperative action in marketing forest products.

The wide-spread adoption of these measures will assure a greater and more valuable forest resource on a permanent basis, and will create added security and opportunity for both the people and the forest industries of the Piedmont.

# GLOSSARY

## General

Forest Survey Unit. -- The term "forest survey unit" denotes an area of 4 to 10 million acres in which topographic, forest, economic, and industrial conditions are reasonably homogeneous.

## Land-use Classes

Productive forest area. -- Forest land having qualities essential for the growth of commercial timber.

Nonproductive forest area. -- Forest land lacking qualities essential for the growth of commercial timber.

Cropland, old and new. -- Land used for production of farm or orchard crops or evidently so used during the past 5 years. This includes new cropland, i.e., land converted from forest to cropland within 5 years prior to survey.

Pasture. -- Cleared or open land under fence used primarily for grazing.

Abandoned cropland. -- Land once cultivated but showing distinct evidence of having been abandoned for agricultural crop production.

Other non-forest. -- Areas included within the corporate limits and surburban or industrial sections of cities and communities; power, rail, and highway rights-of-way; marsh; and nonmeandered waterways.

## Forest Types

Shortleaf pine-hardwoods. -- Stands in which pines make up 25 percent or more of the dominant and codominant stems with shortleaf pine predominating.

Loblolly pine-hardwoods. -- Stands in which pines make up 25 percent or more of the dominant and codominant stems with loblolly pine predominating.

Virginia pine-hardwoods. -- Stands in which pines make up 25 percent or more of the dominant and codominant stems with Virginia pine predominating.

Upland hardwoods. -- Stands in which mixed oaks and other hardwoods make up 75 percent or more of the dominant and codominant stems, usually found on the rolling upland sites.

Bottom-land hardwoods. -- Stands in which hardwoods make up 75 percent or more of the dominant and codominant stems, usually found in river bottoms and swamps.

## Diameters

D.b.h. (diameter at breast height). -- Diameter, outside of bark, measured at $4\frac{1}{2}$ feet from the ground.

Diameter class. -- All trees were recorded in 2-inch diameter classes, including diameters 1.0 inch below and 0.9 above the stated midpoint, e.g., trees 7.0 to 8.9 inches d.b.h. are placed in the 8-inch class.

## Tree Classification

Sound sawlog-size tree. -- A pine, cypress, or redcedar tree at least 9.0 inches d.b.h., or a hardwood tree at least 13.0 inches d.b.h., with not less than one sound butt log 12 feet long, or with 50 percent of the gross volume of the tree in sound saw timber.

Sound under-sawlog-size tree. -- Any tree over 1.0 inch d.b.h. and less than sawlog-size, with a reasonably straight sound stem.

Cull tree. -- Any tree that fails to qualify as a sound sawlog or under-sawlog-size tree because of form, limbiness, rot, or other defect.

Pole tree. -- Pine trees that will produce a pole conforming to specifications of the American Standards Association.

## Forest Conditions

### Sawlog Size

Old growth, uncut. -- Stands composed of trees having the characteristics of the original mature timber of the region and containing at least 1,000 board feet per acre of merchantable species in hardwood types, and 600 board feet per acre in pine types, with less than 10 percent of the volume cut.

Old growth, partly cut. -- Old-growth stands from which 10 percent or more of the volume has been cut, leaving a minimum of 1,000 board feet per acre in the hardwood types, or 600 board feet per acre in the pine types.

Second growth, uncut. -- Stands of second growth having at least 600 board feet per acre in trees of sawlog-size, and with less than 10 percent of the sawlog-size trees removed.

Second growth, partly cut. -- Stands of second growth from which 10 percent or more of the sawlog-size trees have been removed but with the remaining stand containing 600 or more board feet per acre.

### Under Sawlog Size

Second growth. -- Young second-growth stands in which the volume of timber in trees of sawlog size is less than 600 board feet per acre and the remainder of the trees are below sawlog size.

Reproduction. -- Stands too young to classify as second growth having at least 80 well distributed seedlings per acre.

Clear-cut. -- Cut-over areas having insufficient young growth to qualify either as second growth or reproduction.

## Volume Estimates

Board-foot volume. -- Only the saw-timber portion of sawlog-size trees are included in this estimate. Top diameters vary with the limits of usable material. Deductions are made for woods cull and for loss in sawing at the mill.

Cordwood volume. -- This volume (including bark) is derived from the following sources:

1. The sawlog portion of sawlog-size trees.

2. The portion of saw-timber trees not usable as sawlogs but acceptable as cordwood. This includes the upper stems of pine and cedar and, unless otherwise noted, the upper stems and limbs of hardwoods and cypress. The minimum diameter limit is 4.0 inches outside bark.

3. The full stem of sound under-sawlog-size trees, at least 5.0 inches d.b.h., to a variable top diameter not less than 4.0 inches outside bark.

4. The estimated sound material in cull trees.

Deductions for cull include only the volume in defects which cause the material to be unsuited for cordwood. Sweep and slight crook are not regarded as defects.

Cubic-foot volume. -- This volume is derived from the same sources as the cordwood volume except that bark is not included.

Standard cord. -- A stacked pile of round or split wood bolts measuring 4' x 4' x 8' and estimated to contain 90 cubic feet of wood and bark in the pine, cedar, and cypress species, and 80 cubic feet of wood and bark in the hardwood species.

## Increment

Growing stock. -- The sum of the volumes of all sound trees 5.0 inches d.b.h. and larger; dead and cull trees and tops of hardwood and cypress not included.

Board-foot increment. -- Includes the net growth on the saw-timber portion of sawlog-size trees, plus the volume in sound trees reaching sawlog-size.

Cordwood increment. -- Includes the net growth on the sound stemwood of pines and cedar 5.0 inches d.b.h. and over, on under sawlog-size hardwoods and cypress, and on the sawlog portion of sawlog-size hardwoods and cypress, plus the sound-tree volume of all species reaching 5.0 inches d.b.h. during the increment period.

Cubic-foot increment. -- Omits bark volumes, otherwise material is identical with cordwood.

## Mortality

Mortality. -- The volume lost from the growing stock of the forest through the death of individual trees. Natural causes of mortality include lightning, tree competition, old age, disease, insects, drought, and wind. Fire is the major man-caused source of mortality.

## Site Index

Site index. -- The average height attained by dominant and codominant trees at 50 years of age.